US006513677B1

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Sorensen et al.

(10) **Patent No.: US 6,513,677 B1**
(45) **Date of Patent: Feb. 4, 2003**

(54) **APPARATUS AND METHOD FOR VENDING PRODUCTS**

(75) Inventors: **Steven W. Sorensen**, Maplewood, MN (US); **James E. Skavnak**, Minneapolis, MN (US); **Thomas F. Gotich**, Eagan, MN (US); **Scott Hudis**, Stillwater, MN (US); **Joseph A. Lotspeich**, West St. Paul, MN (US)

(73) Assignee: **Gross-Given Manufacturing Company**, St. Paul, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 33 days.

(21) Appl. No.: **09/679,963**

(22) Filed: **Oct. 5, 2000**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/172,556, filed on Oct. 14, 1998, now Pat. No. 6,328,180, which is a continuation-in-part of application No. 08/949,366, filed on Oct. 14, 1997, now Pat. No. 6,230,930.

(51) **Int. Cl.**[7] **B65G 59/00**
(52) **U.S. Cl.** ..... **221/130**; 221/131; 221/242; 221/312 R
(58) **Field of Search** ..... 221/130, 131, 221/95, 242, 312 R; 312/35, 42, 45, 72; 211/59.2, 59.4

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F631 Frozen Merchandiser; FASTCORP; Ice cream and frozen food vendor; 1 page, 2 sided brochure.

Primary Examiner—David H. Bollinger
(74) *Attorney, Agent, or Firm*—Merchant & Gould P.C.

(57) **ABSTRACT**

An improved method and apparatus for vending products, and particularly beverage containers, of varied sizes, shapes and configurations without dropping or subjecting the vended product to damaging impact forces are disclosed. The products to be vended are aligned in selectable ordered queues within a vending machine that can include a transparent front panel. A robotic carriage assembly using rack and pinion assemblies moves in positive non-vibratory manner along an X-Y plane in the machine, captures the selected product from its queue and smoothly transports the product to a product delivery port conveniently located close to hip level. The carriage assembly uses unique product escapement and capture mechanisms to smoothly slide the related product from its queue into the carriage. Power door and safety lock features at the delivery port are also disclosed.

15 Claims, 23 Drawing Sheets

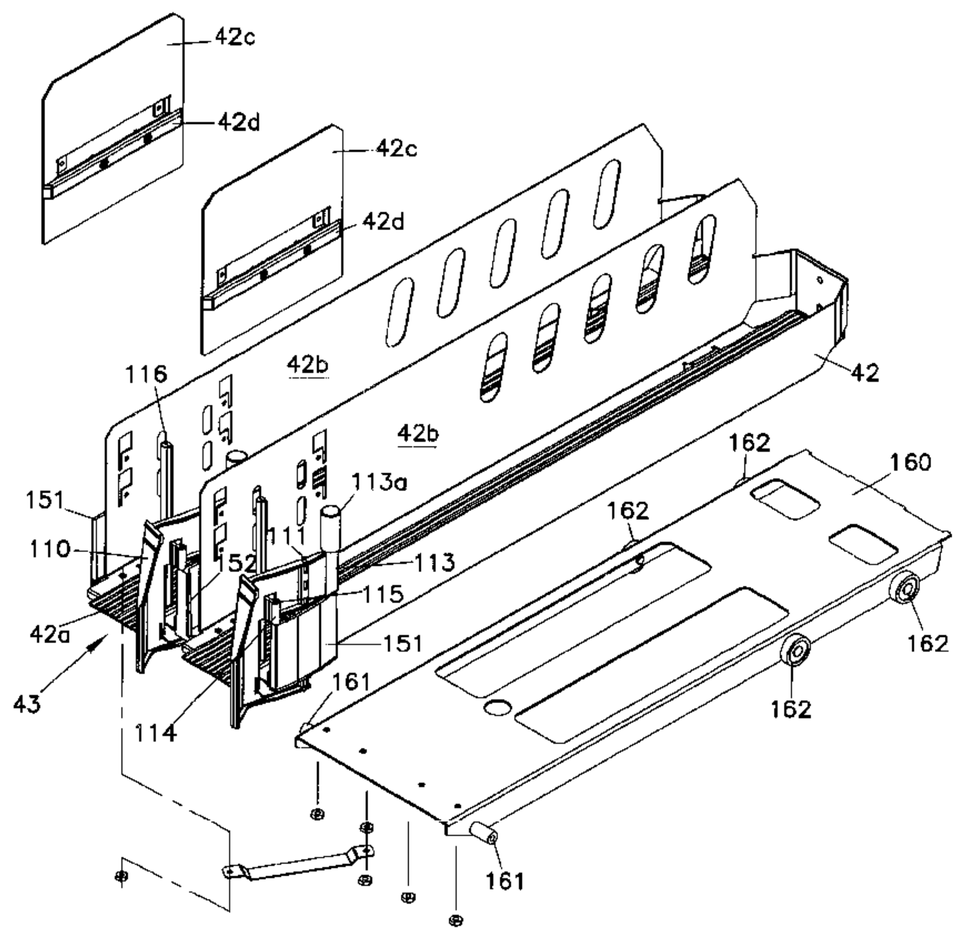

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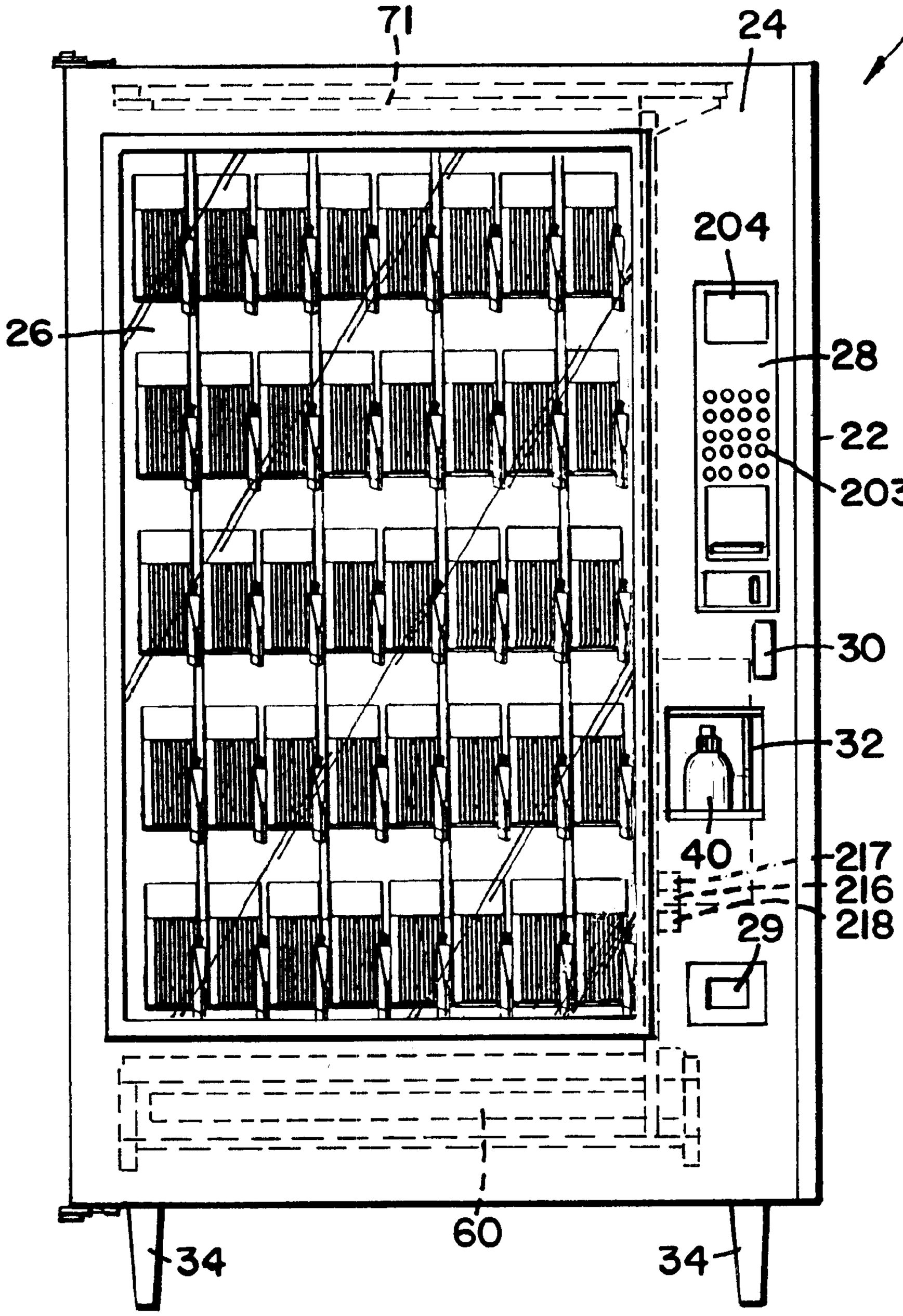
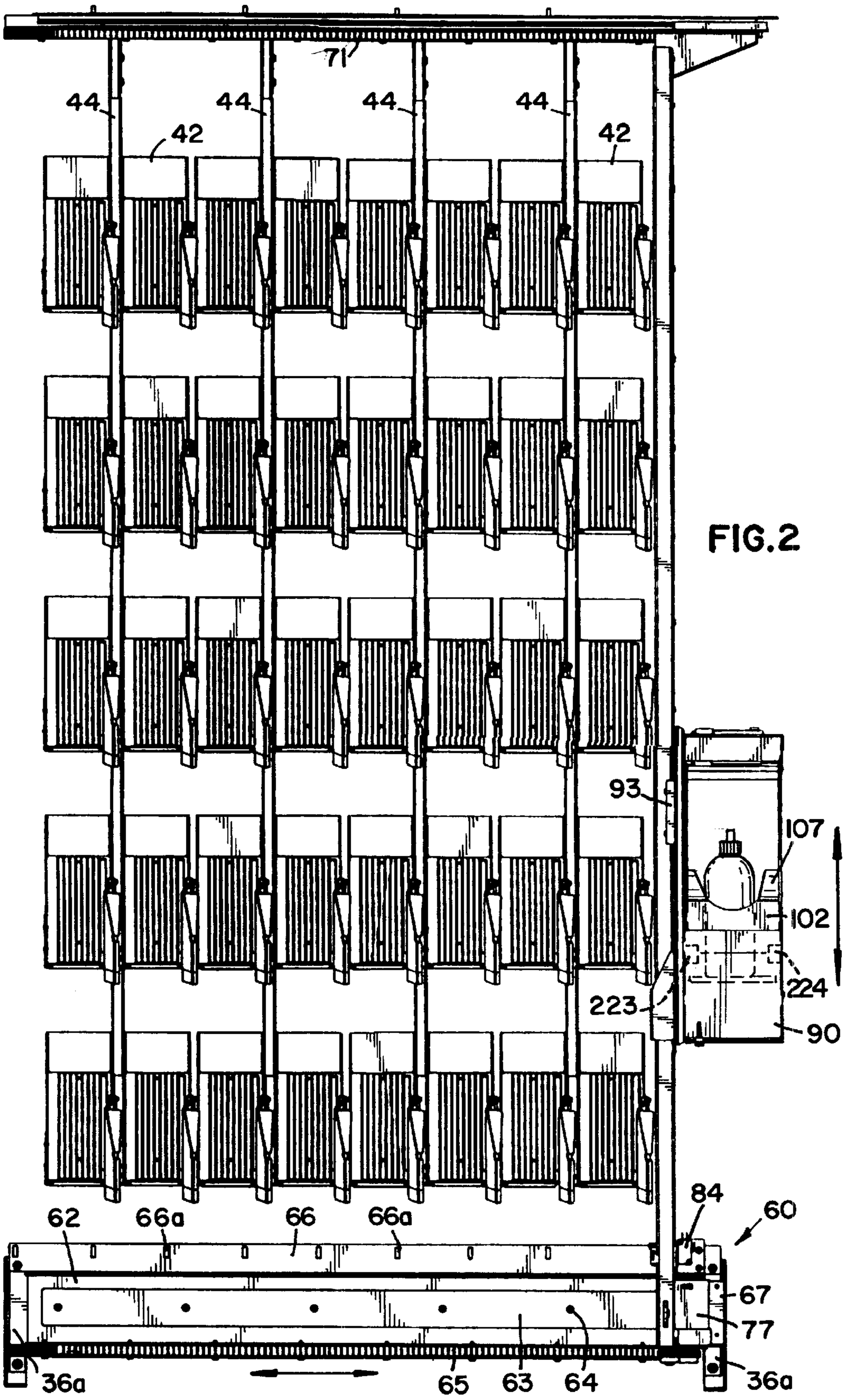
FIG. 1

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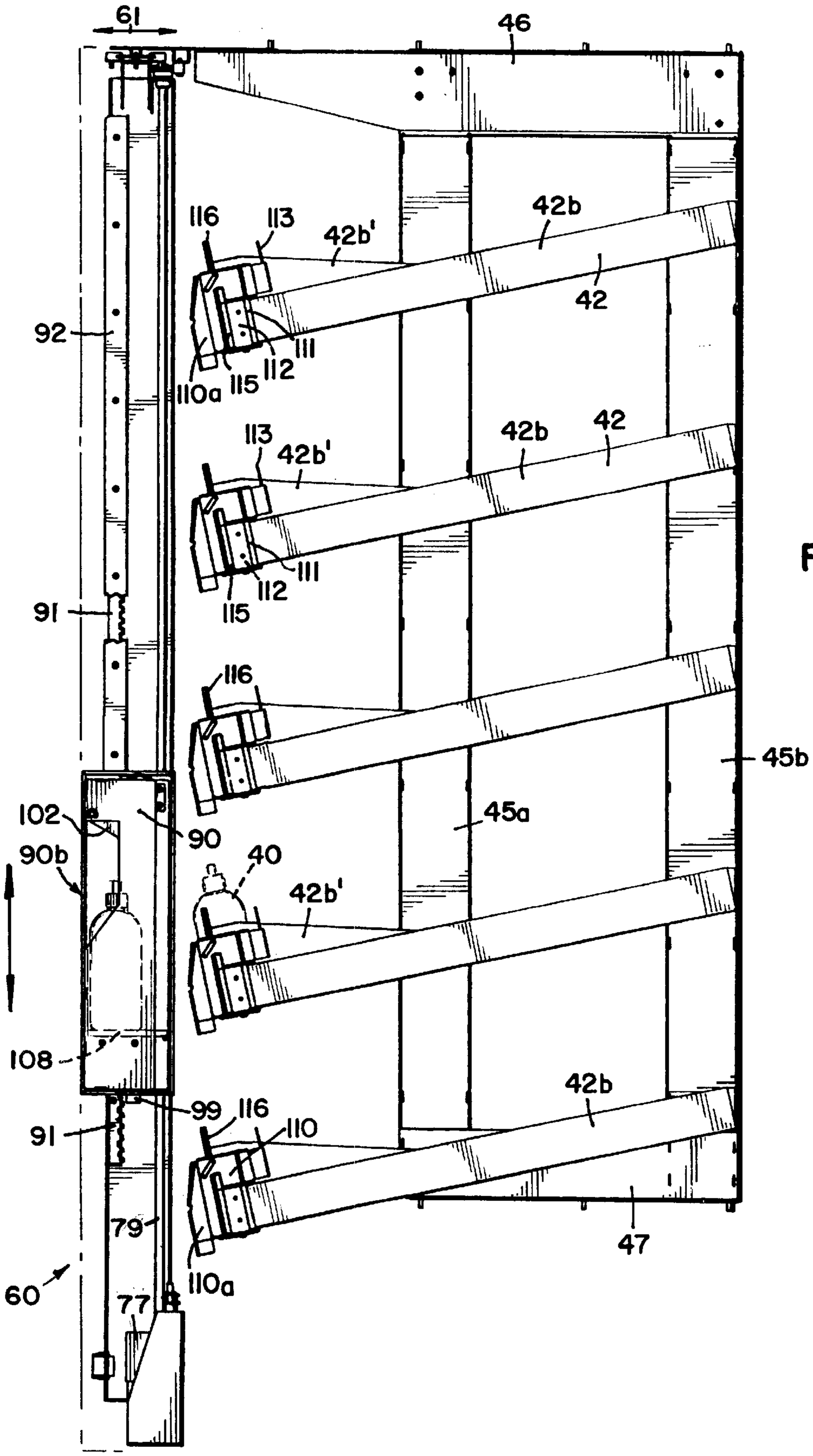
44
44
44
44
42
42
93
107
102
224
223
90
84
60
67
77
62
66a
66
66a
36a
65
63
64
36a

FIG.2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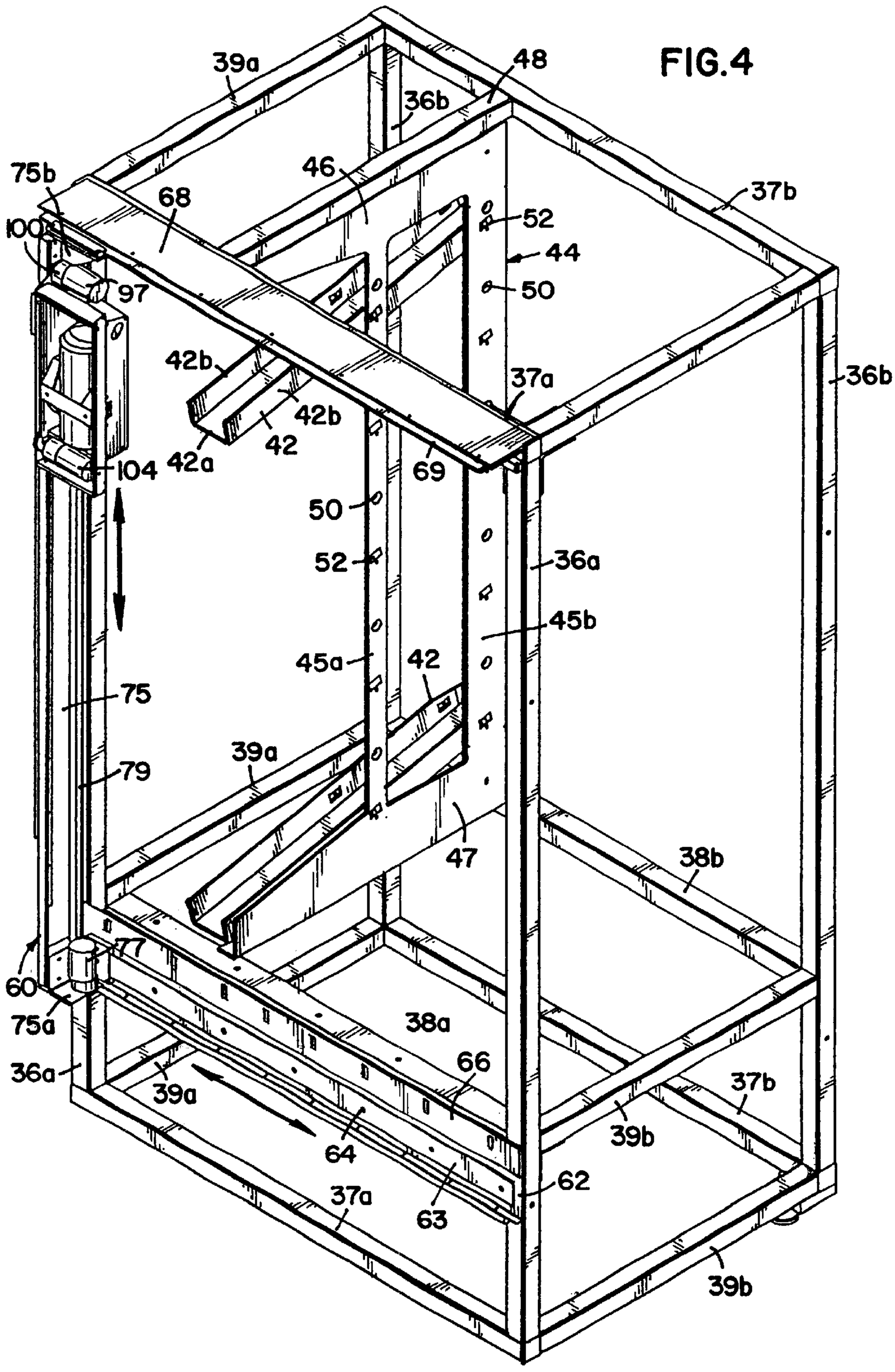
46
116
113
42b'
42b
42
92
111
112
115
110a
113
42b'
42b
42
111
112
115
91
116
45b
45a
102
90
90b
40
42b'
108
99
116
110
42b
91
79
47
60
77
110a

FIG.3

FIG.4


39a
48
36b
75b
46
68
37b
100
52
44
97
50
42b
37a
36b
42b
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42a
104
69
50
52
36a
45b
45a
42
75
79
39a
47
38b
77
60
75a
38a
36a
66
39a
37b
39b
64
62
37a
63
39b

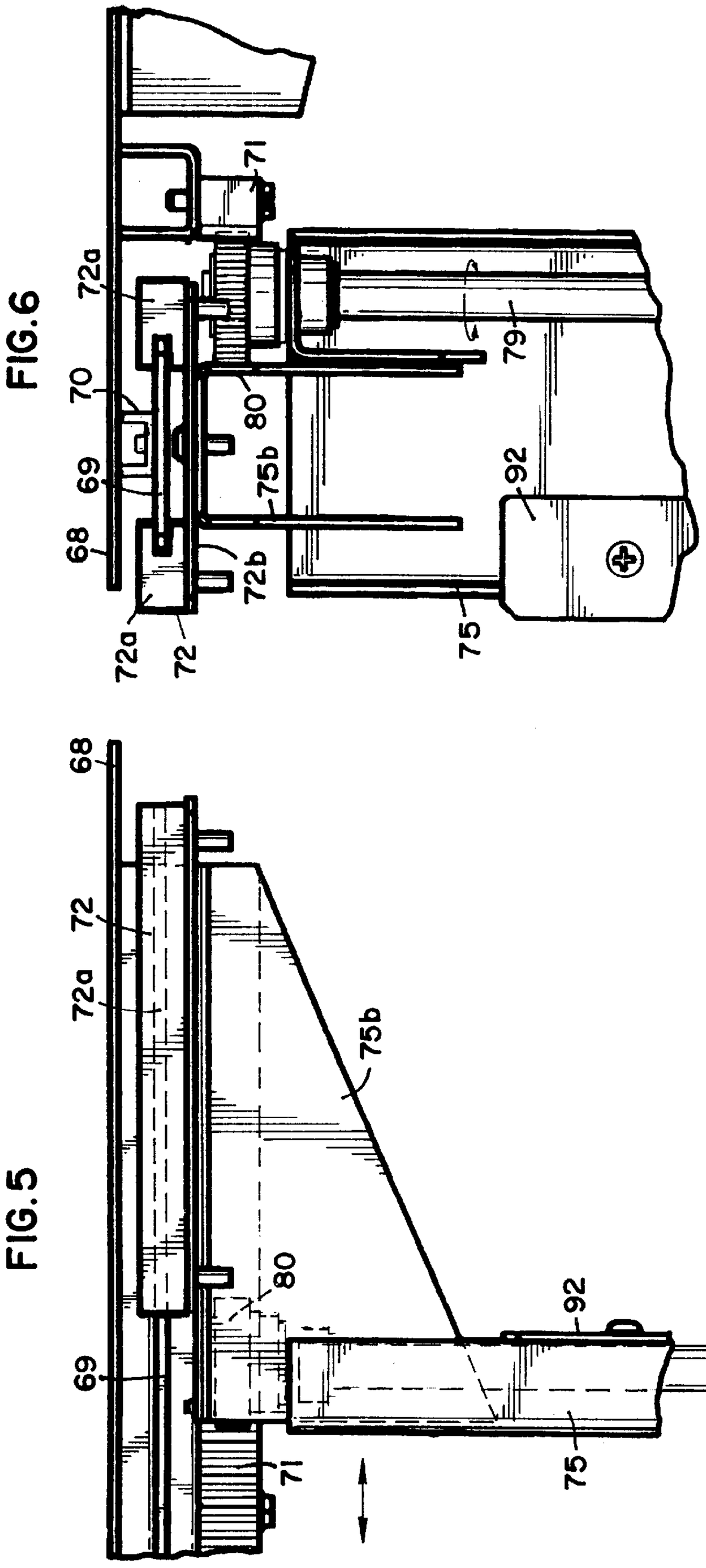
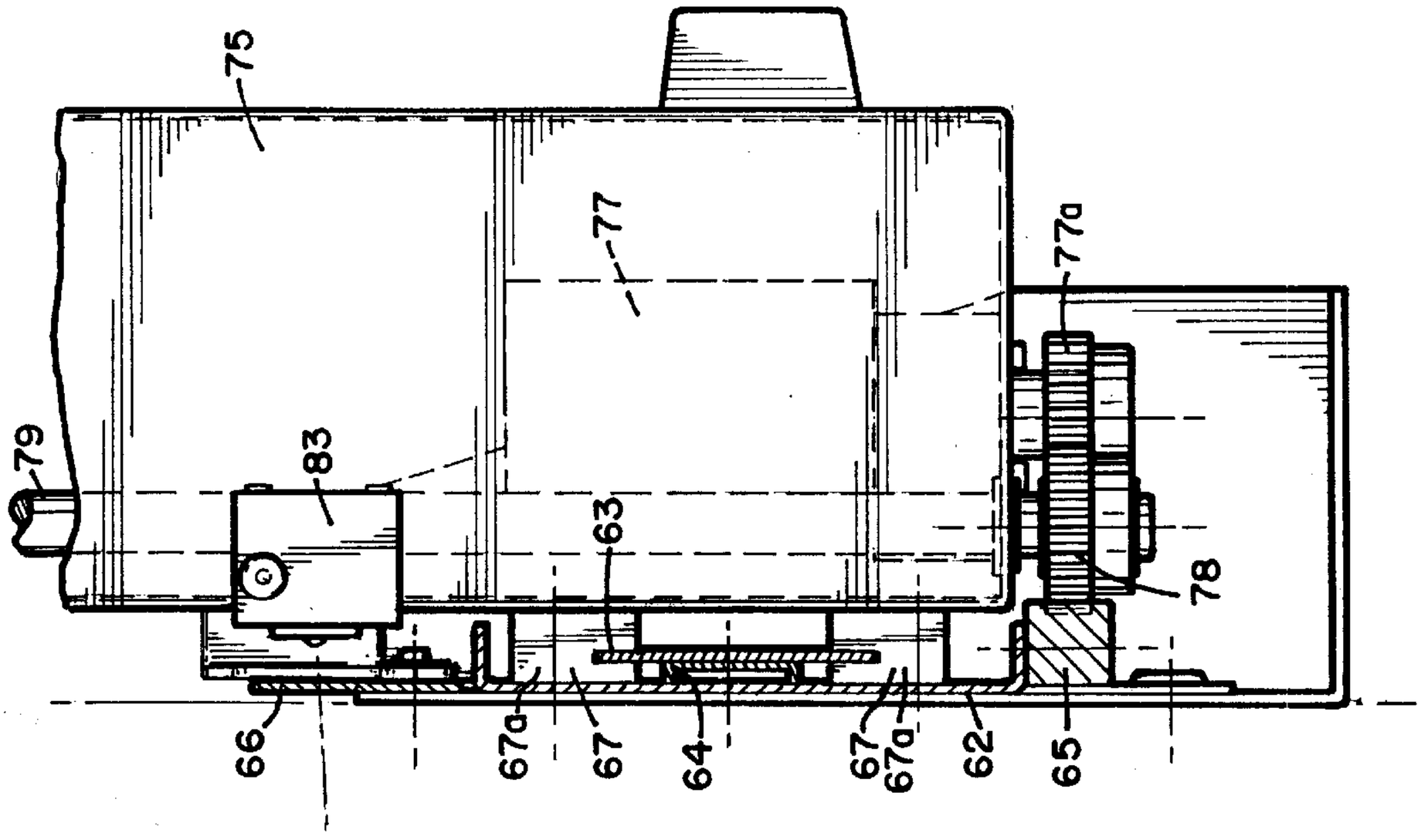

71
72a
70
69
68
72b
72a
72
80
75b
92
79
75

FIG.6

68
72
72a
75b
80
92
79
69
71
75

FIG.5

FIG. 8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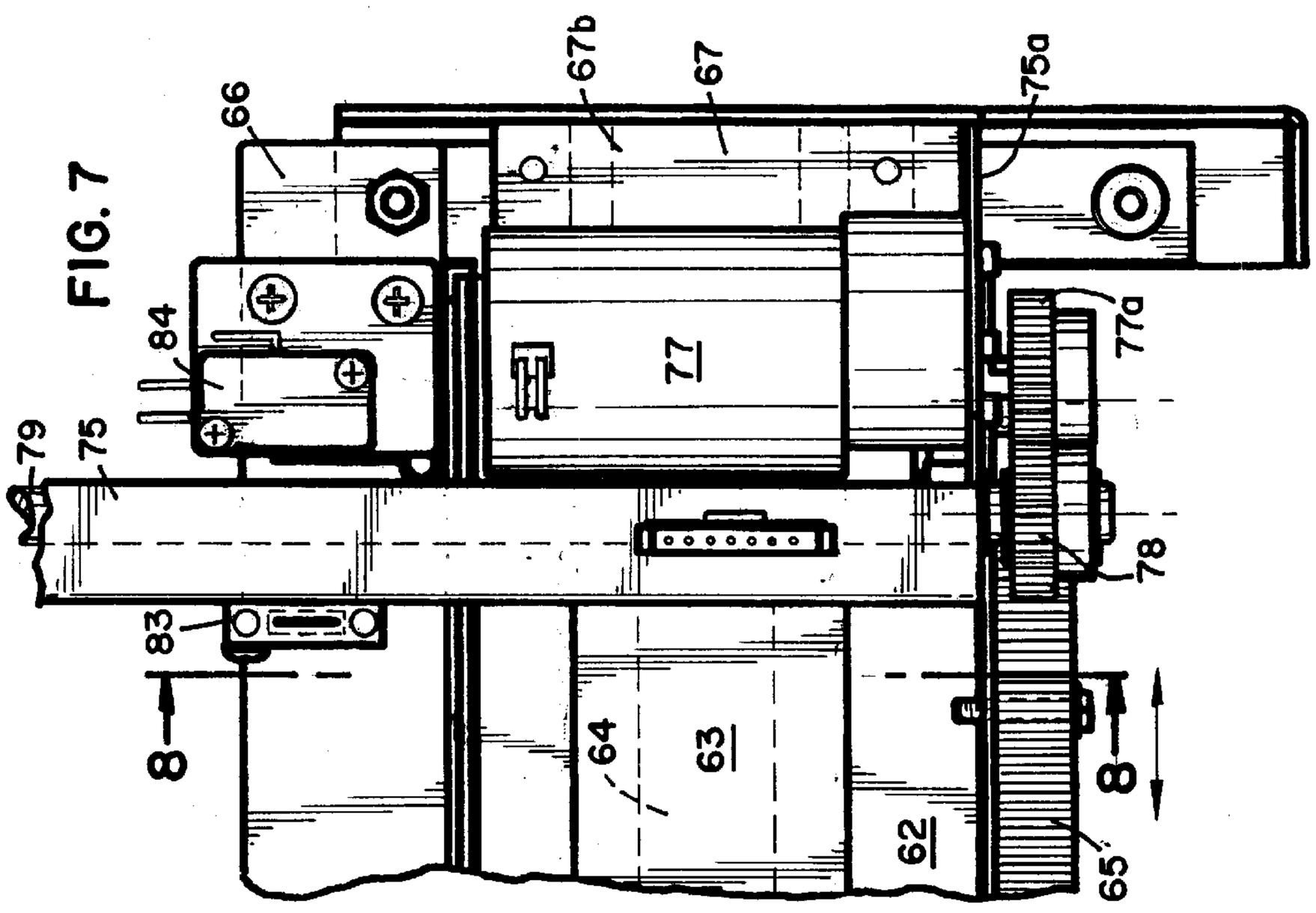
77
77a
79
83
63
78
66
67a
67
64
67
67a
62
65

FIG. 7


67b
67
75a
66
84
77
77a
79
75
78
83
64
63
62
65
8
8

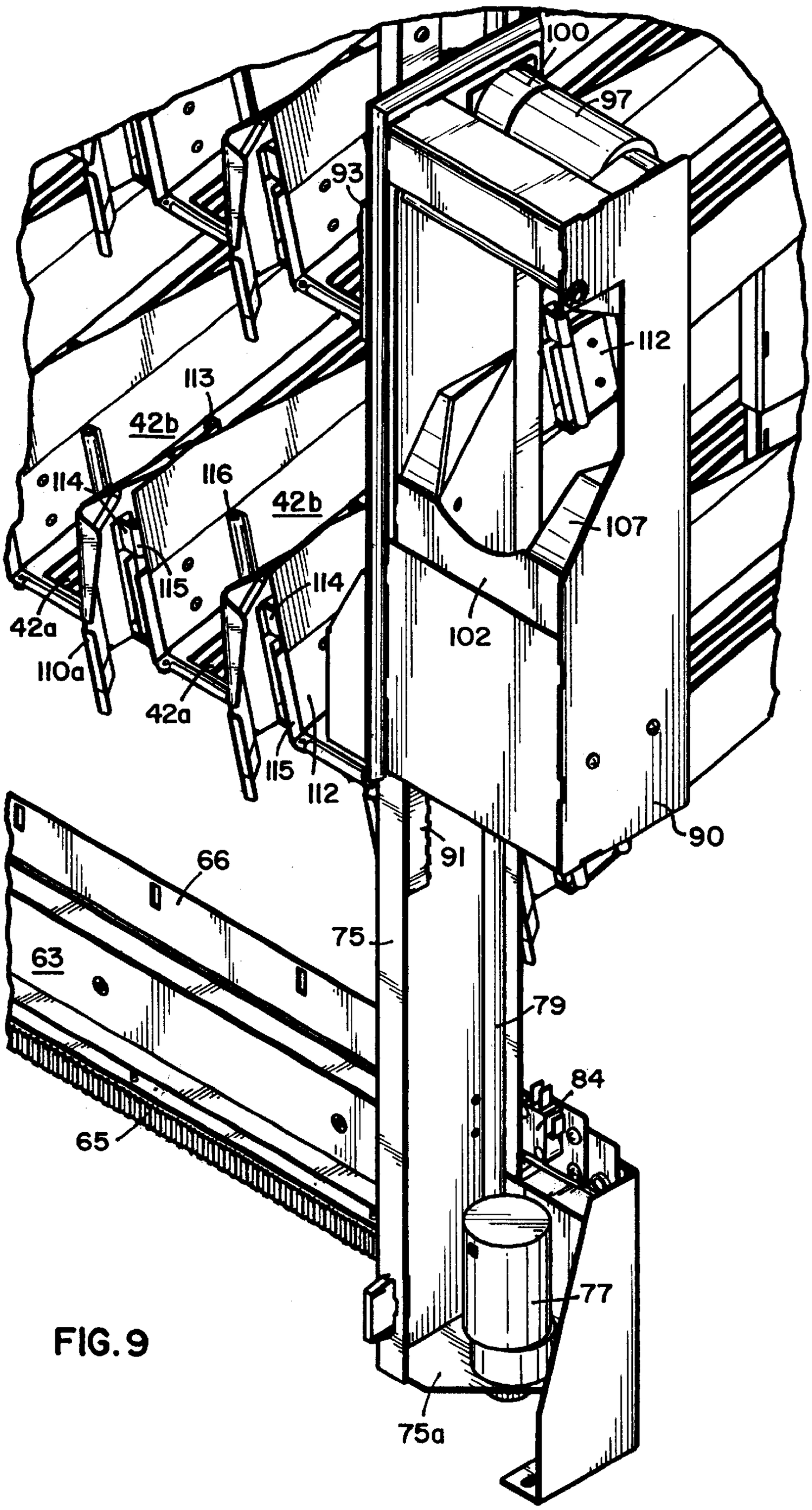

100
97
93
112
113
42b
114
116
42b
107
115
114
42a
102
110a
42a
115
112
91
90
66
75
63
79
84
65
77
75a

FIG. 9

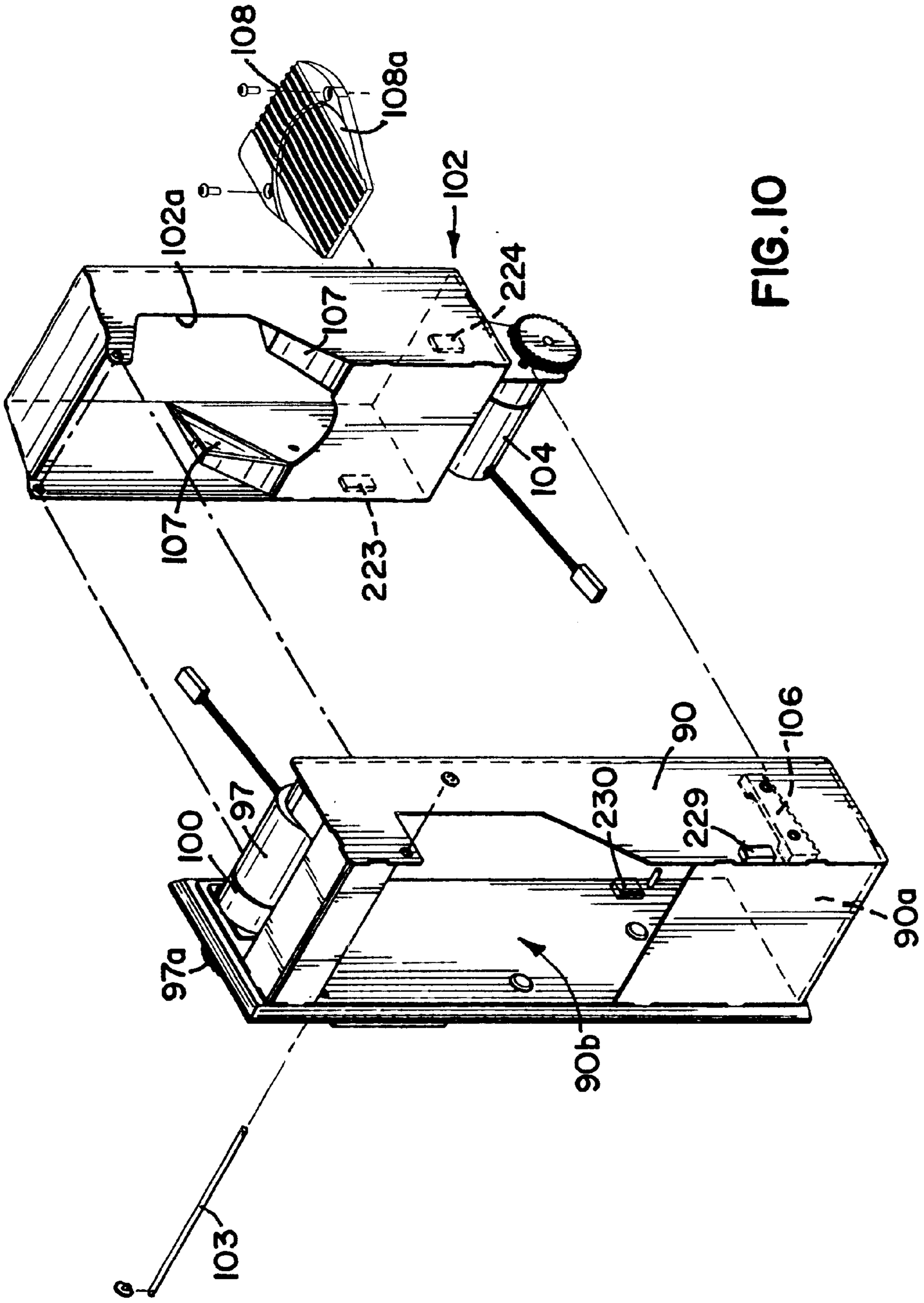

108
108a
102
102a
224
107
107
223
104
97
100
97a
90
106
230
229
90a
90b
103

FIG. 10

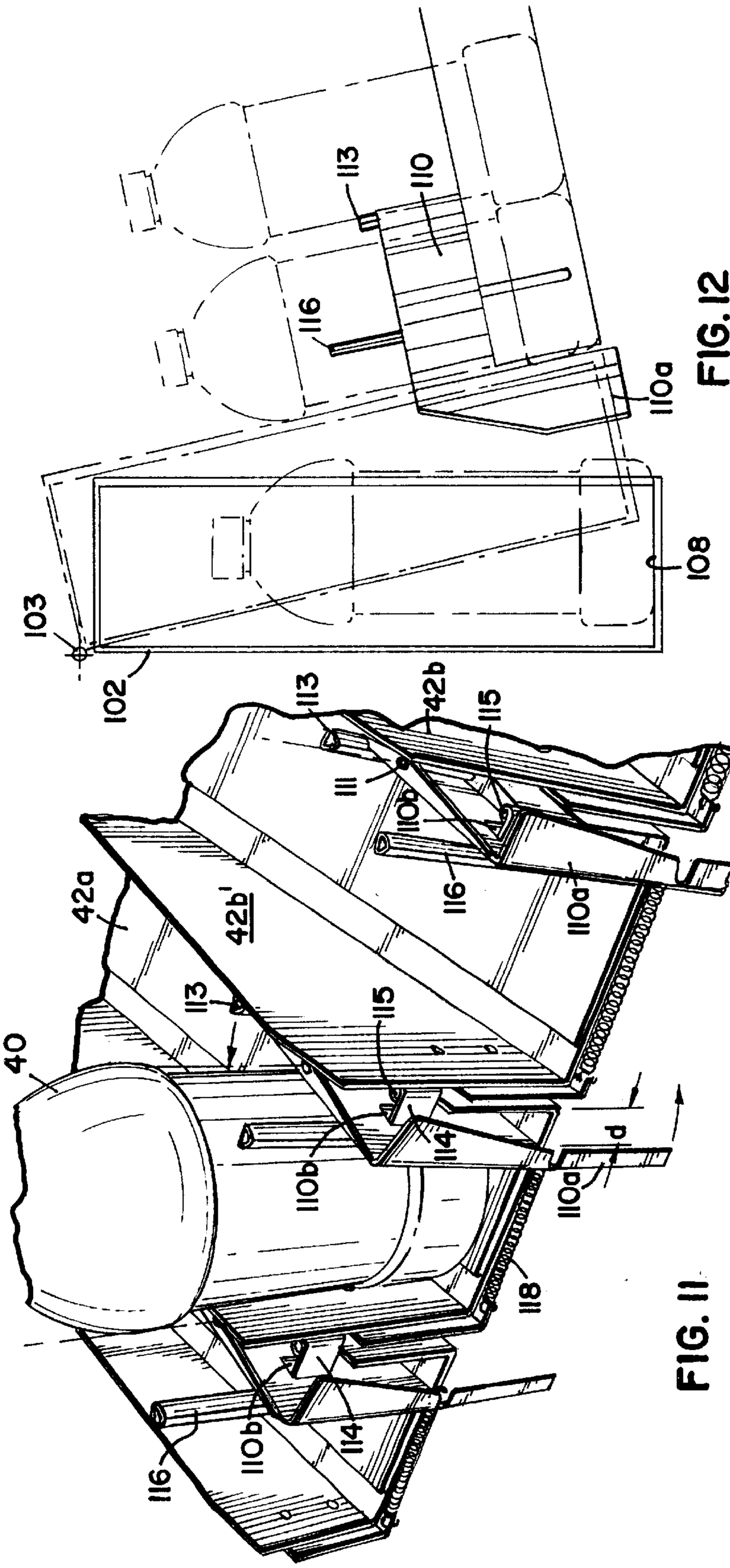

113
110
116
110a
108
103
102
42b
115
111
110b
116
110a'
42a
42b'
113
115
40
114
110b
110a'
118
116
110b'
114

FIG. 12

FIG. 11

FIG. 13A

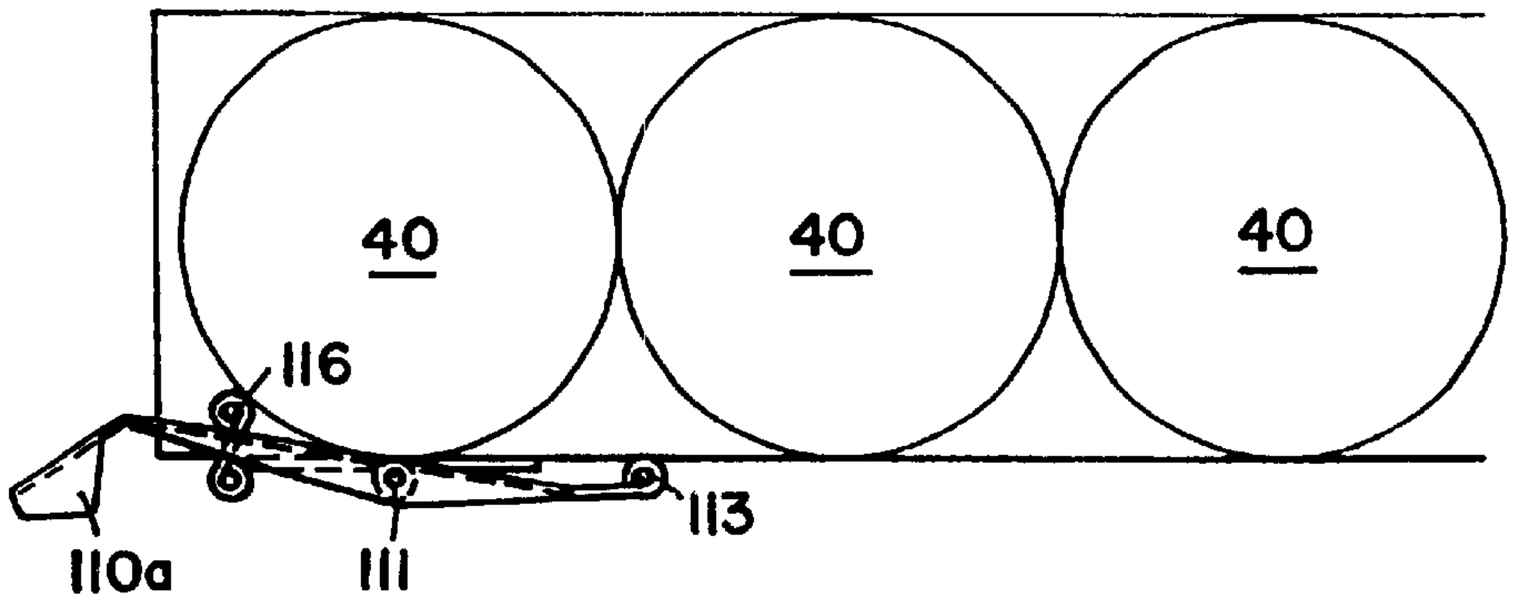


FIG. 13B

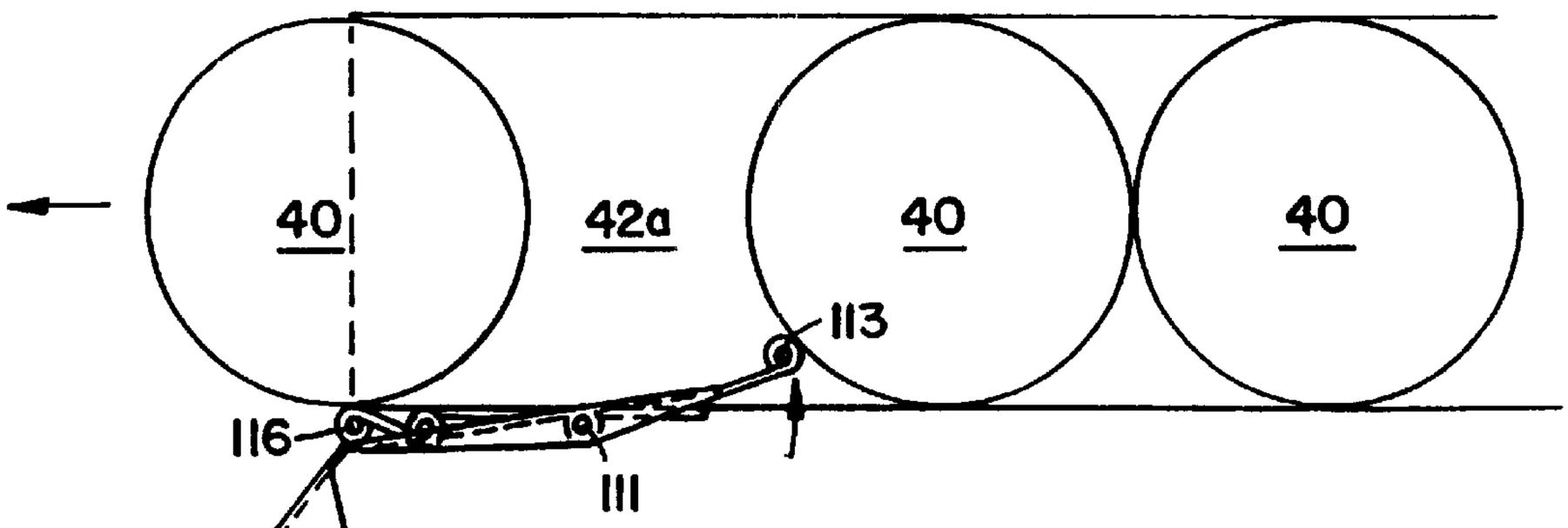


FIG. 13C

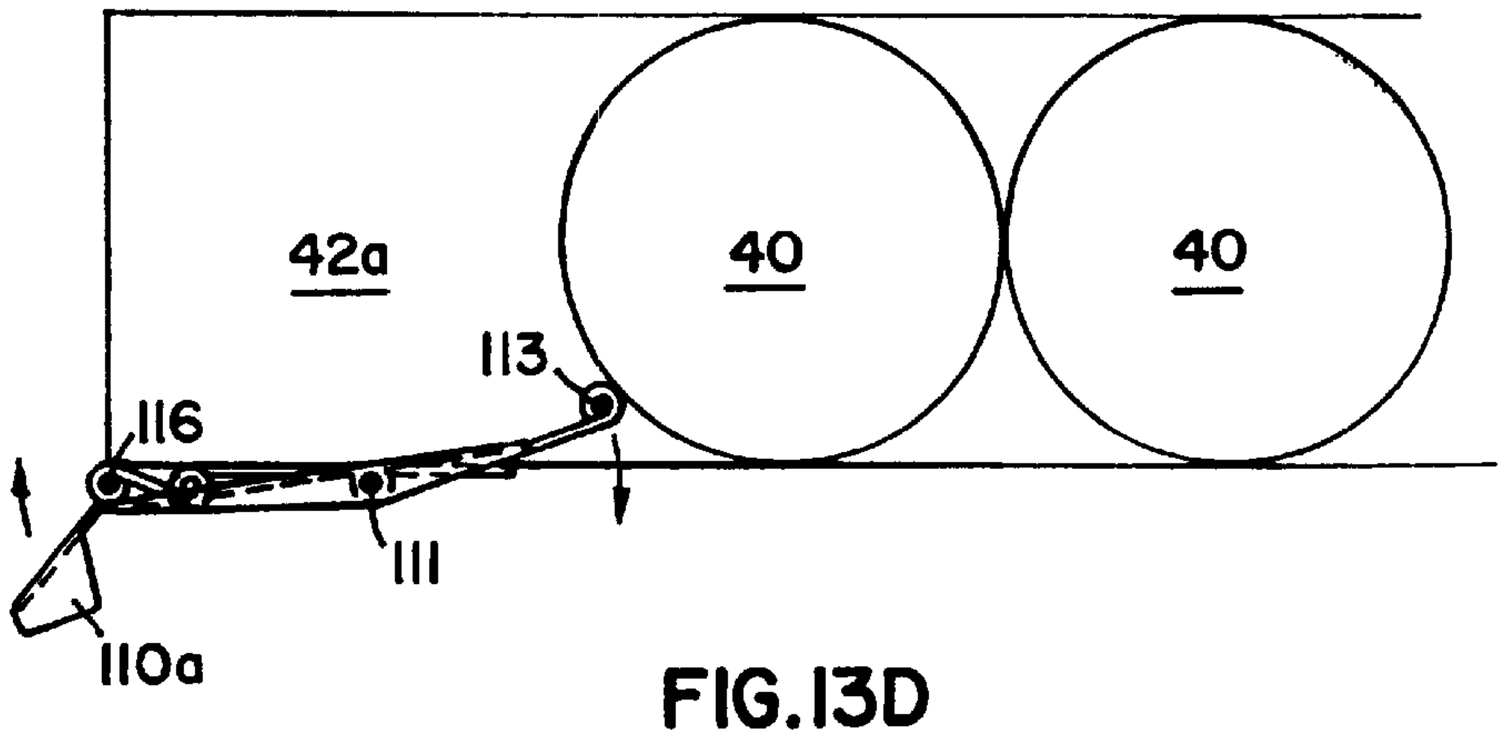
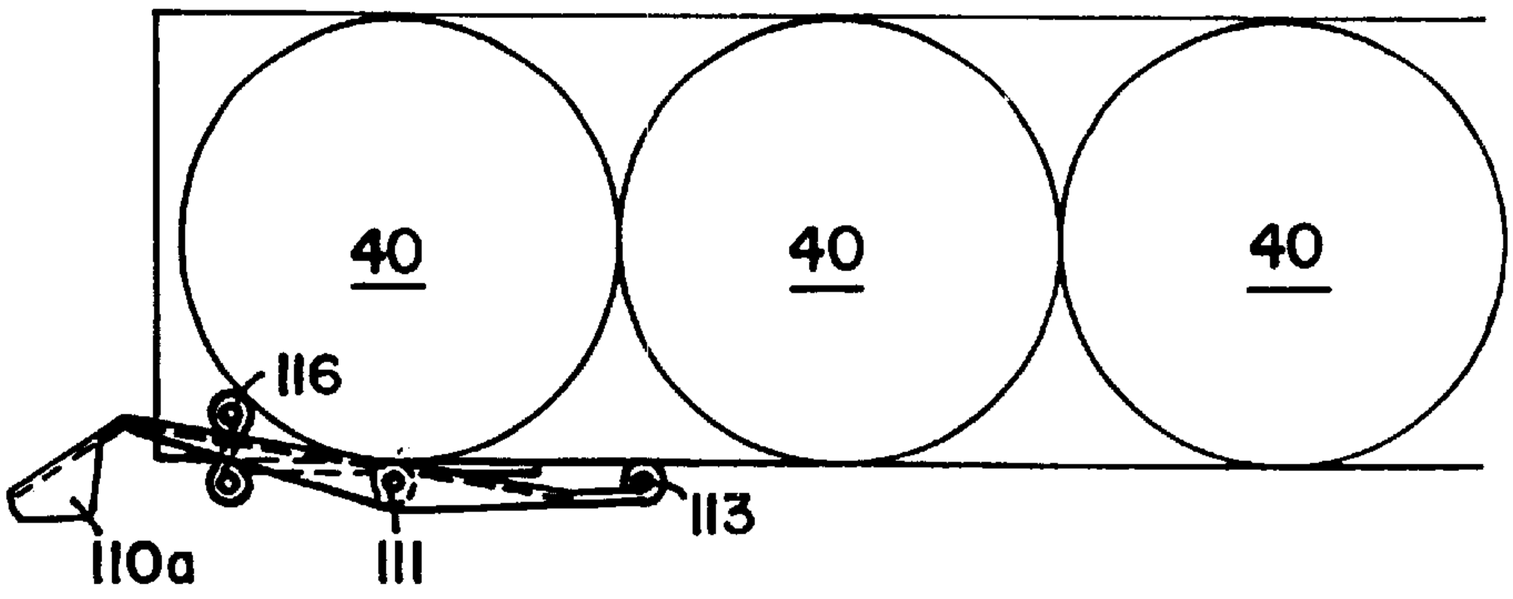


FIG. 13D



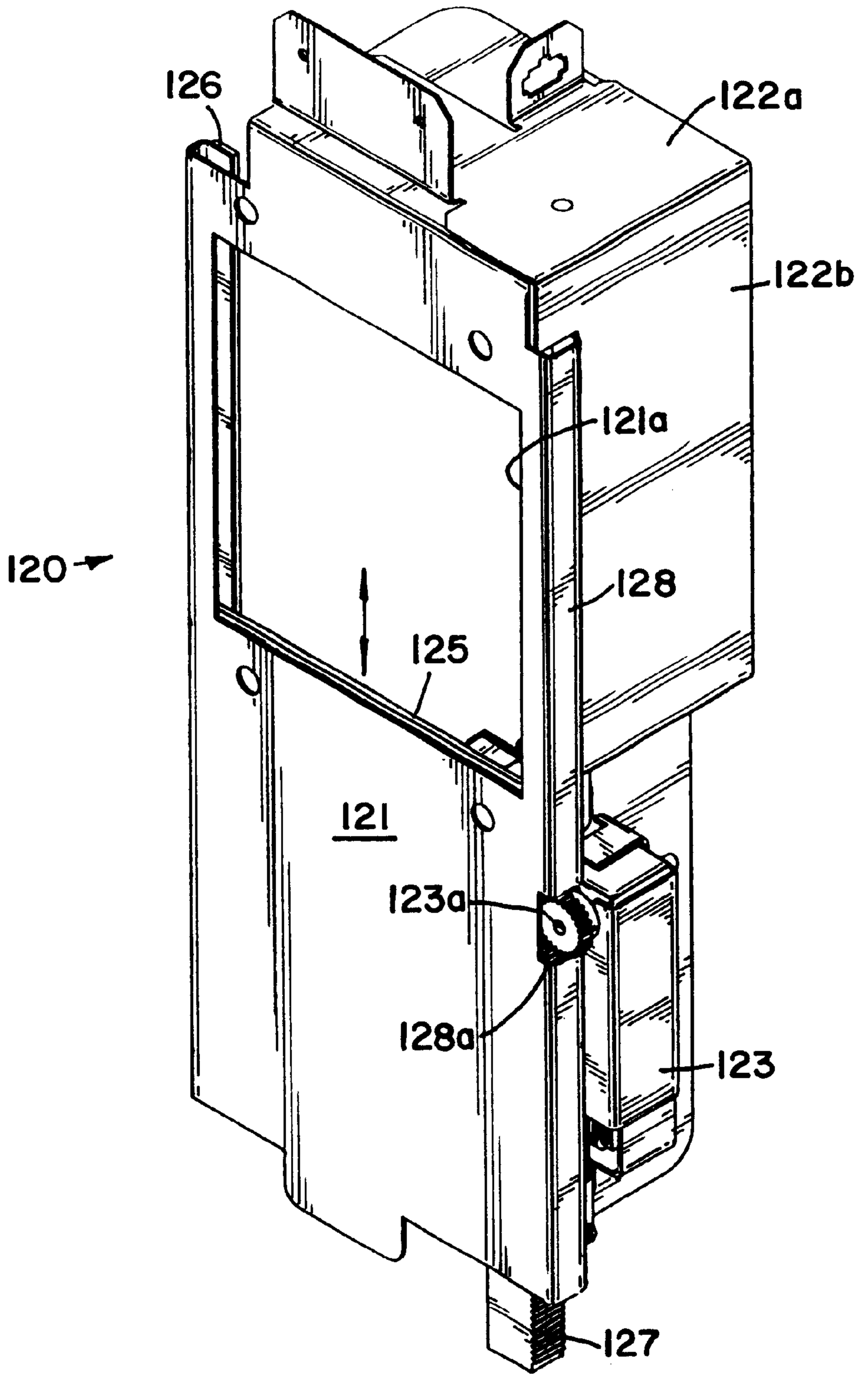


FIG. 14

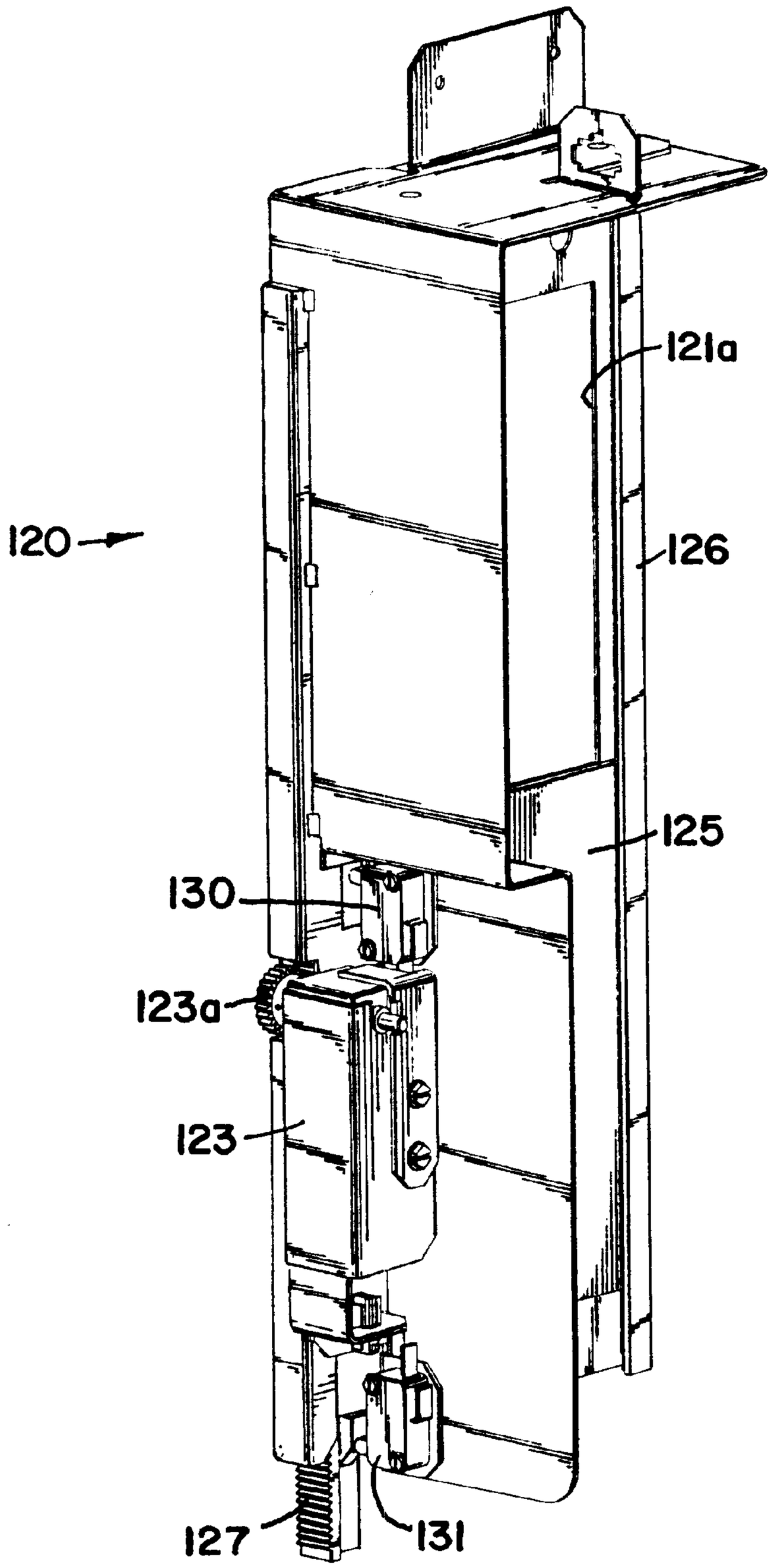


FIG. 15

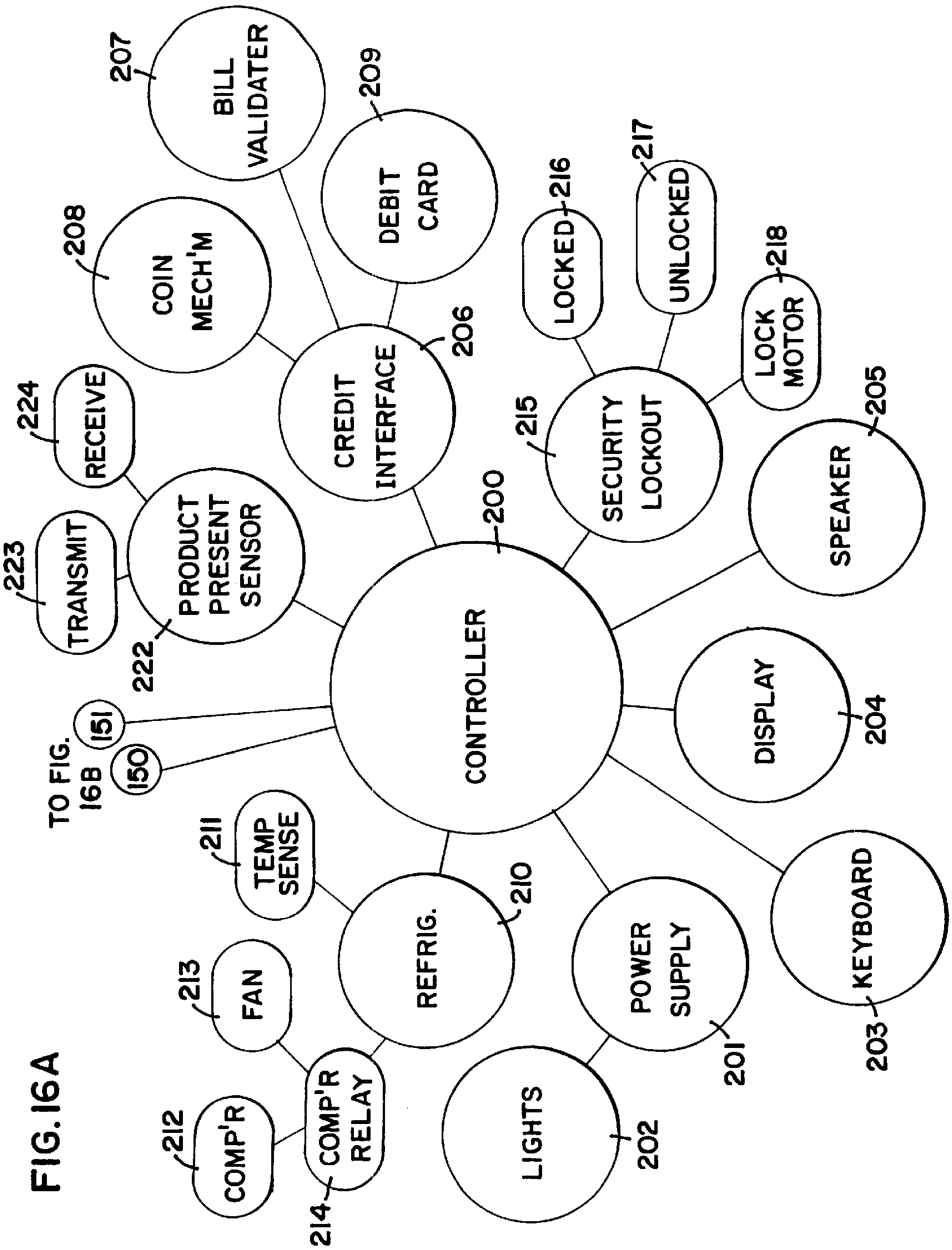
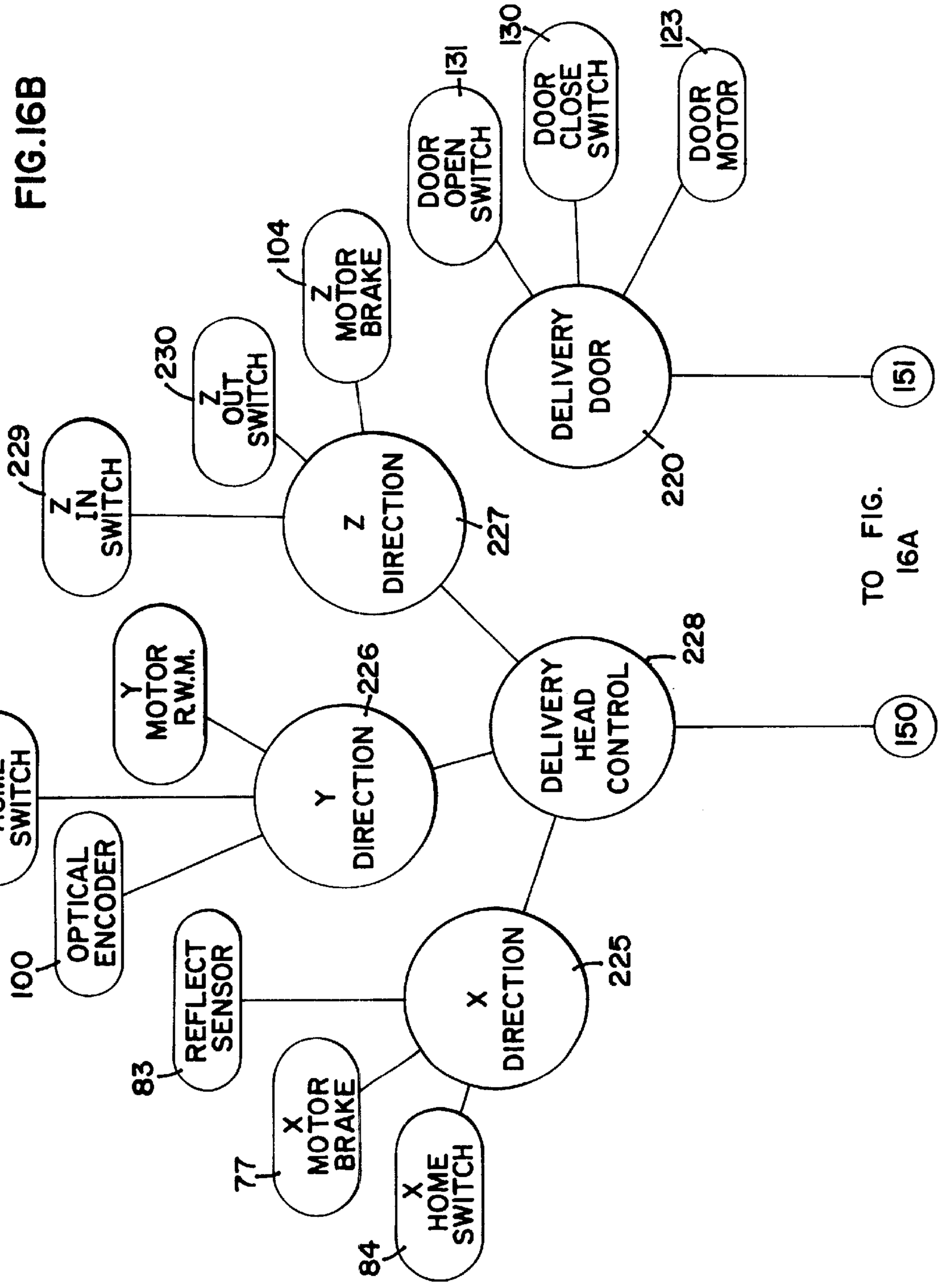

CONTROLLER
200
CREDIT INTERFACE
206
BILL VALIDATER
207
COIN MECH'M
208
DEBIT CARD
209
SECURITY LOCKOUT
215
LOCKED
216
UNLOCKED
217
LOCK MOTOR
218
SPEAKER
205
DISPLAY
204
KEYBOARD
203
POWER SUPPLY
201
LIGHTS
202
REFRIG.
210
TEMP SENSE
211
FAN
213
COMP'R
212
COMP'R RELAY
214
PRODUCT PRESENT SENSOR
222
RECEIVE
224
TRANSMIT
223
TO FIG. 16B
151
150
TO FIG. 16B
168

FIG. 16A

FIG.16B


DOOR OPEN SWITCH
131
DOOR CLOSE SWITCH
130
DOOR MOTOR
123
Z MOTOR BRAKE
104
Z OUT SWITCH
230
Z IN SWITCH
229
Z DIRECTION
227
DELIVERY DOOR
220
151
TO FIG. 16A
DELIVERY HEAD CONTROL
228
150
Y MOTOR R.W.M.
Y HOME SWITCH
99
Y DIRECTION
226
OPTICAL ENCODER
100
REFLECT SENSOR
83
X DIRECTION
225
X MOTOR BRAKE
77
X HOME SWITCH
84

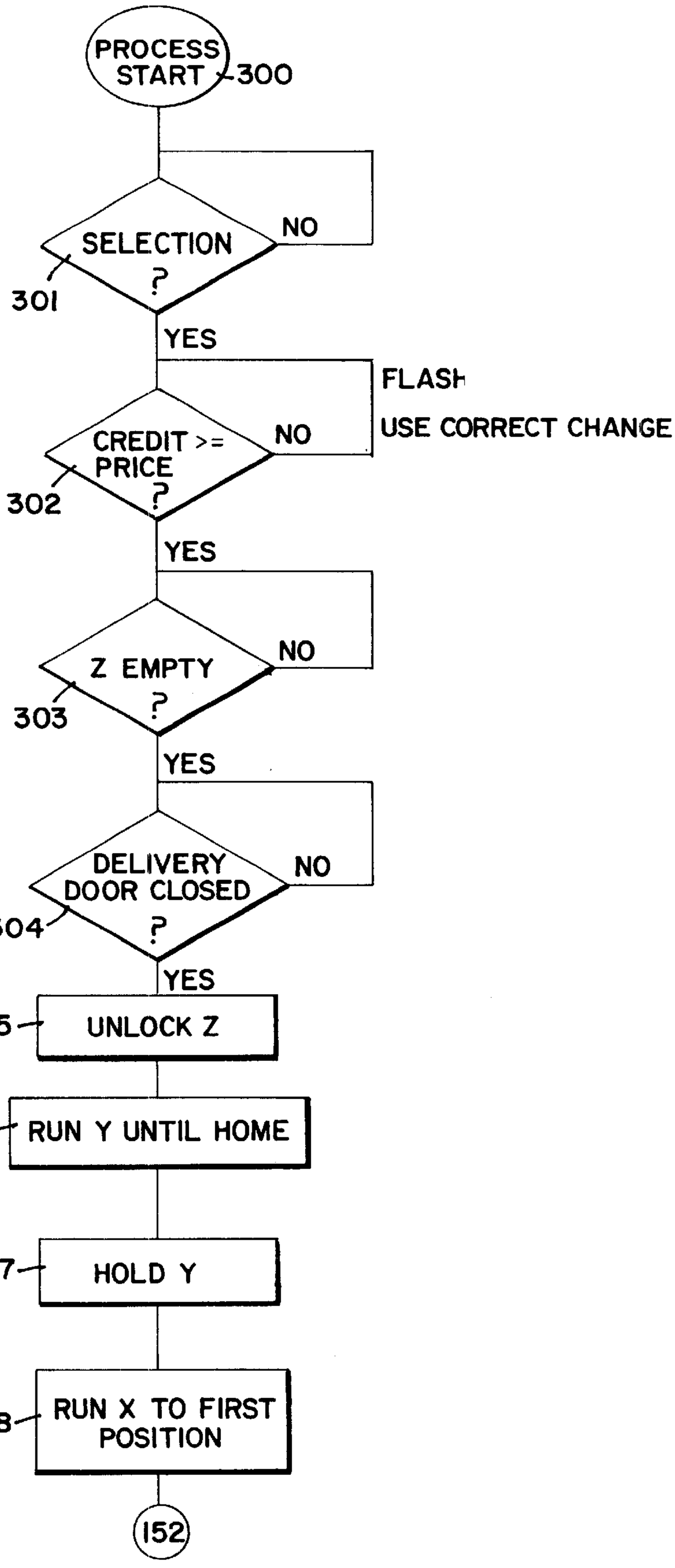

PROCESS START
300
SELECTION ?
301
NO
YES
CREDIT >= PRICE ?
302
NO
FLASH
USE CORRECT CHANGE
YES
Z EMPTY ?
303
NO
YES
DELIVERY DOOR CLOSED ?
304
NO
YES
305
UNLOCK Z
306
RUN Y UNTIL HOME
307
HOLD Y
308
RUN X TO FIRST POSITION
152

FIG. 17A

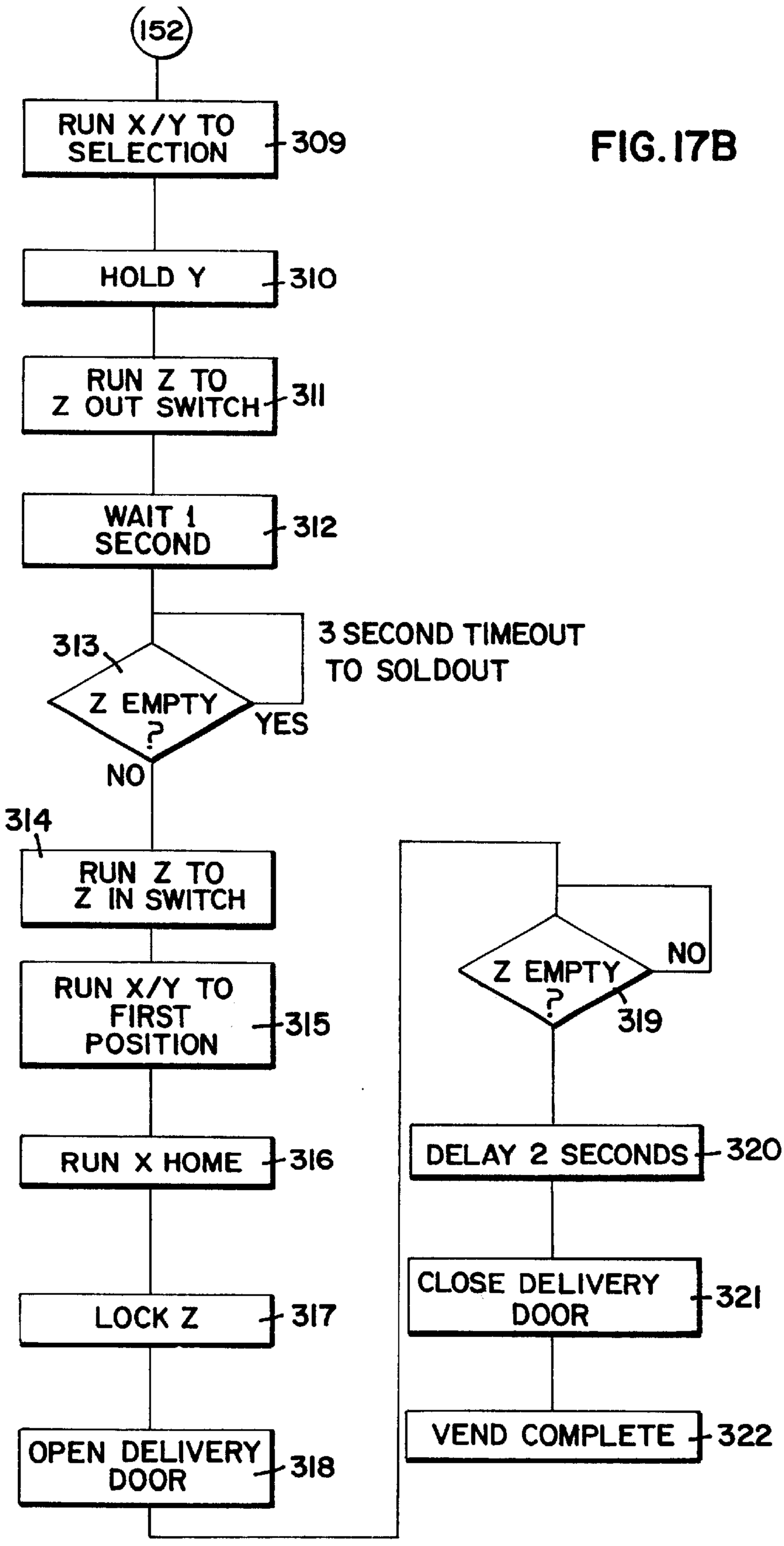
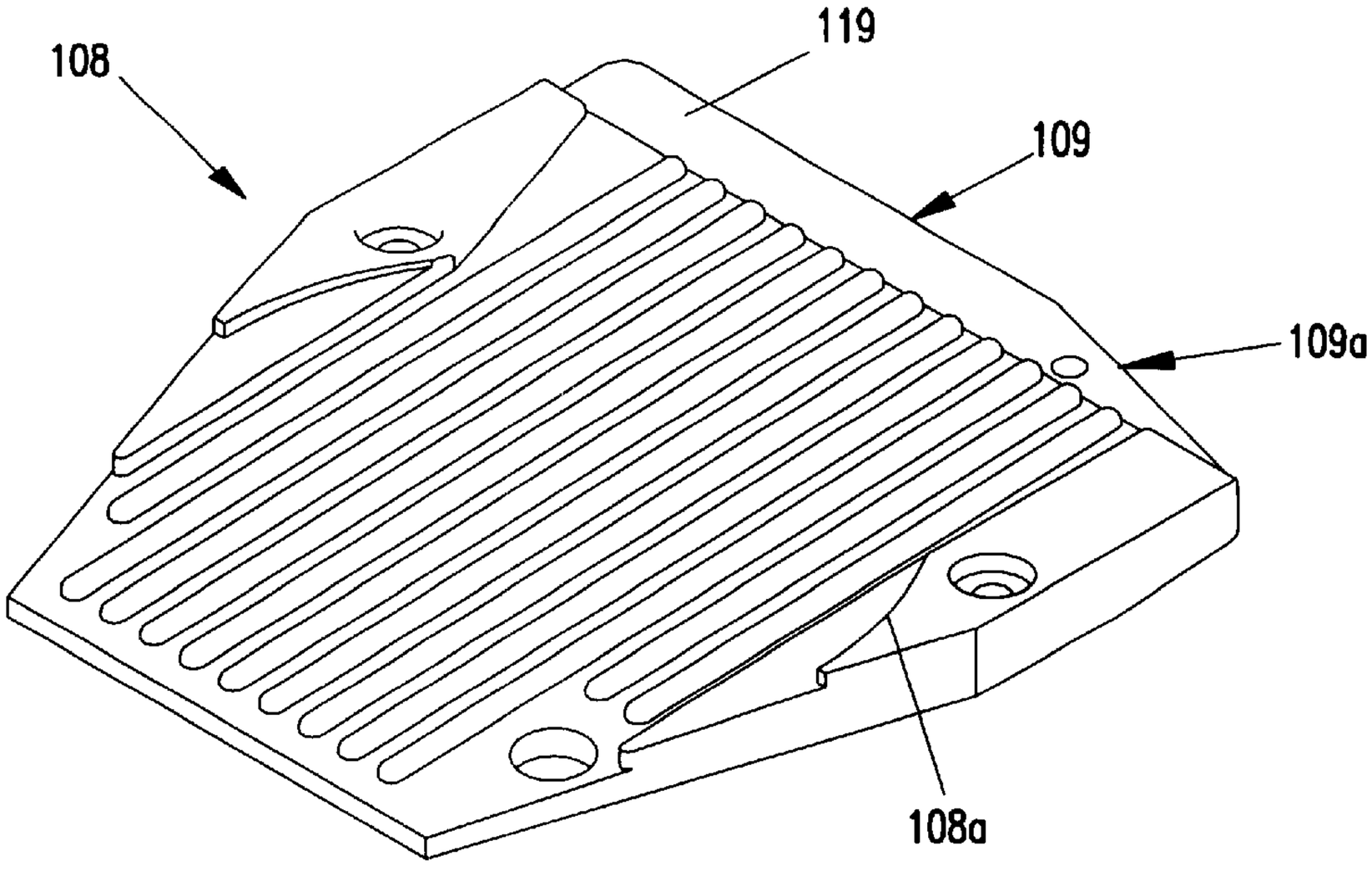

152
RUN X/Y TO SELECTION
309
HOLD Y
310
RUN Z TO Z OUT SWITCH
311
WAIT 1 SECOND
312
313
Z EMPTY ?
YES
3 SECOND TIMEOUT TO SOLDOUT
NO
314
RUN Z TO Z IN SWITCH
RUN X/Y TO FIRST POSITION
315
RUN X HOME
316
LOCK Z
317
OPEN DELIVERY DOOR
318
Z EMPTY ?
NO
319
DELAY 2 SECONDS
320
CLOSE DELIVERY DOOR
321
VEND COMPLETE
322

FIG. 17B

FIG. 18



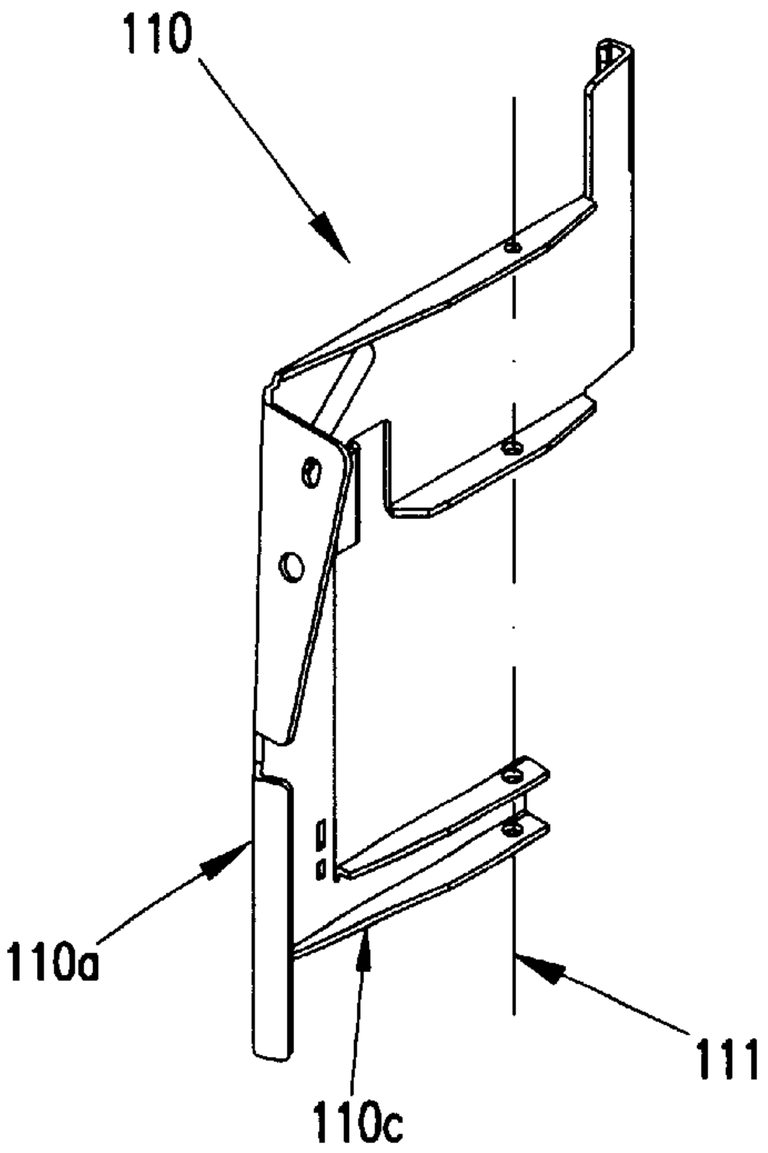


FIG. 21

FIG. 19

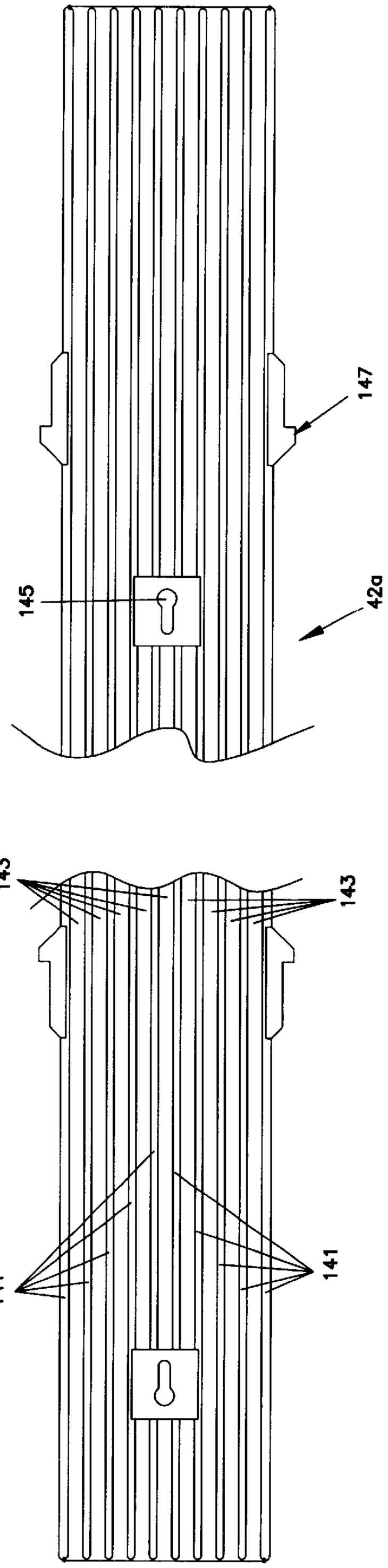


FIG. 20

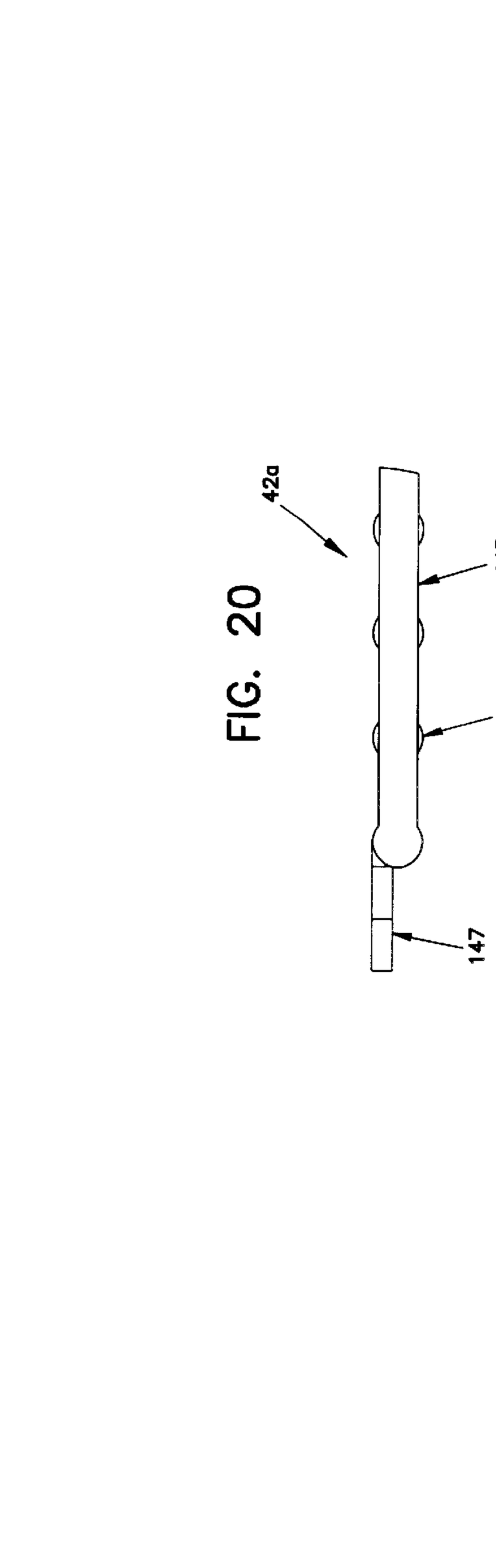
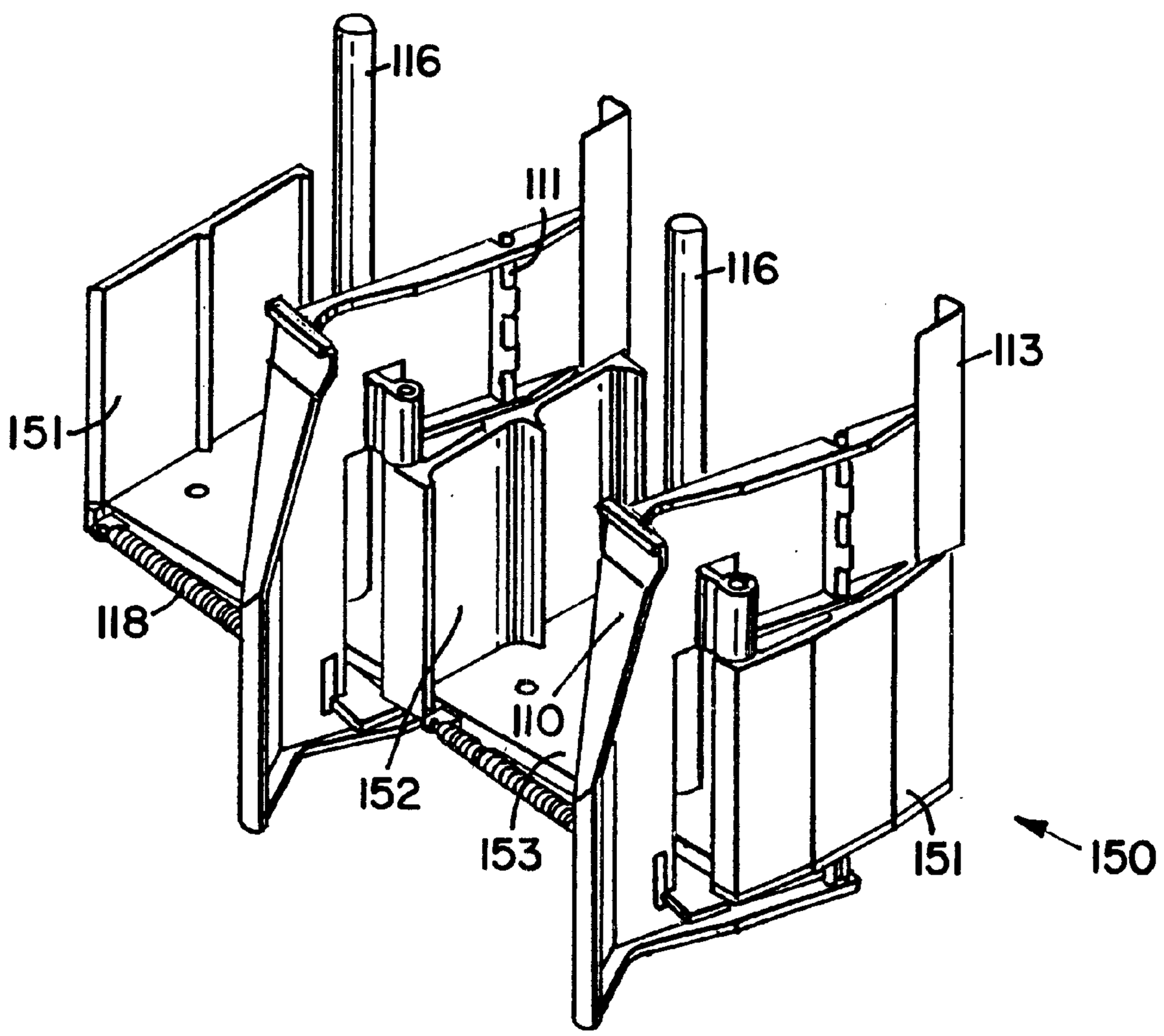


FIG. 22



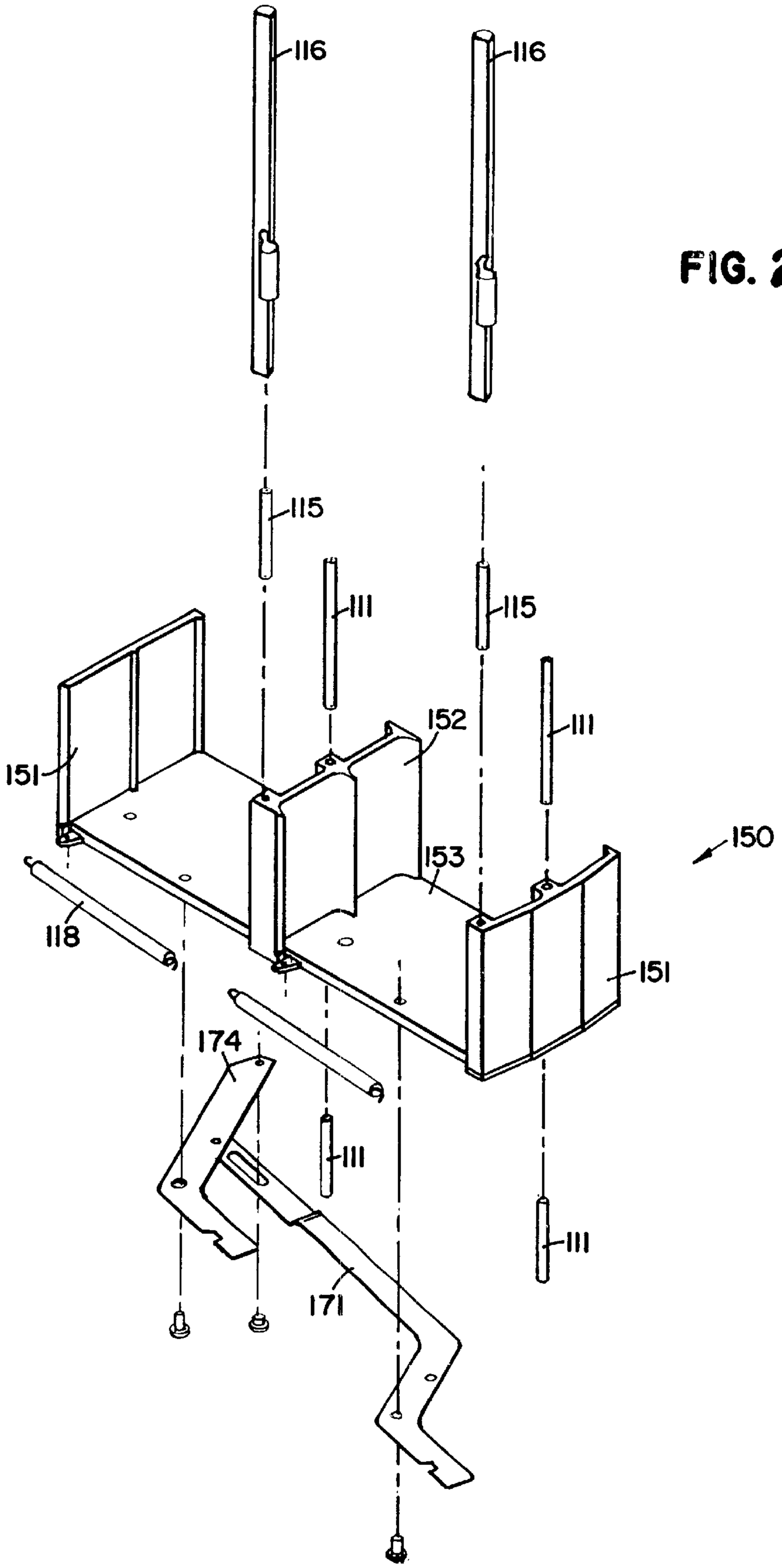
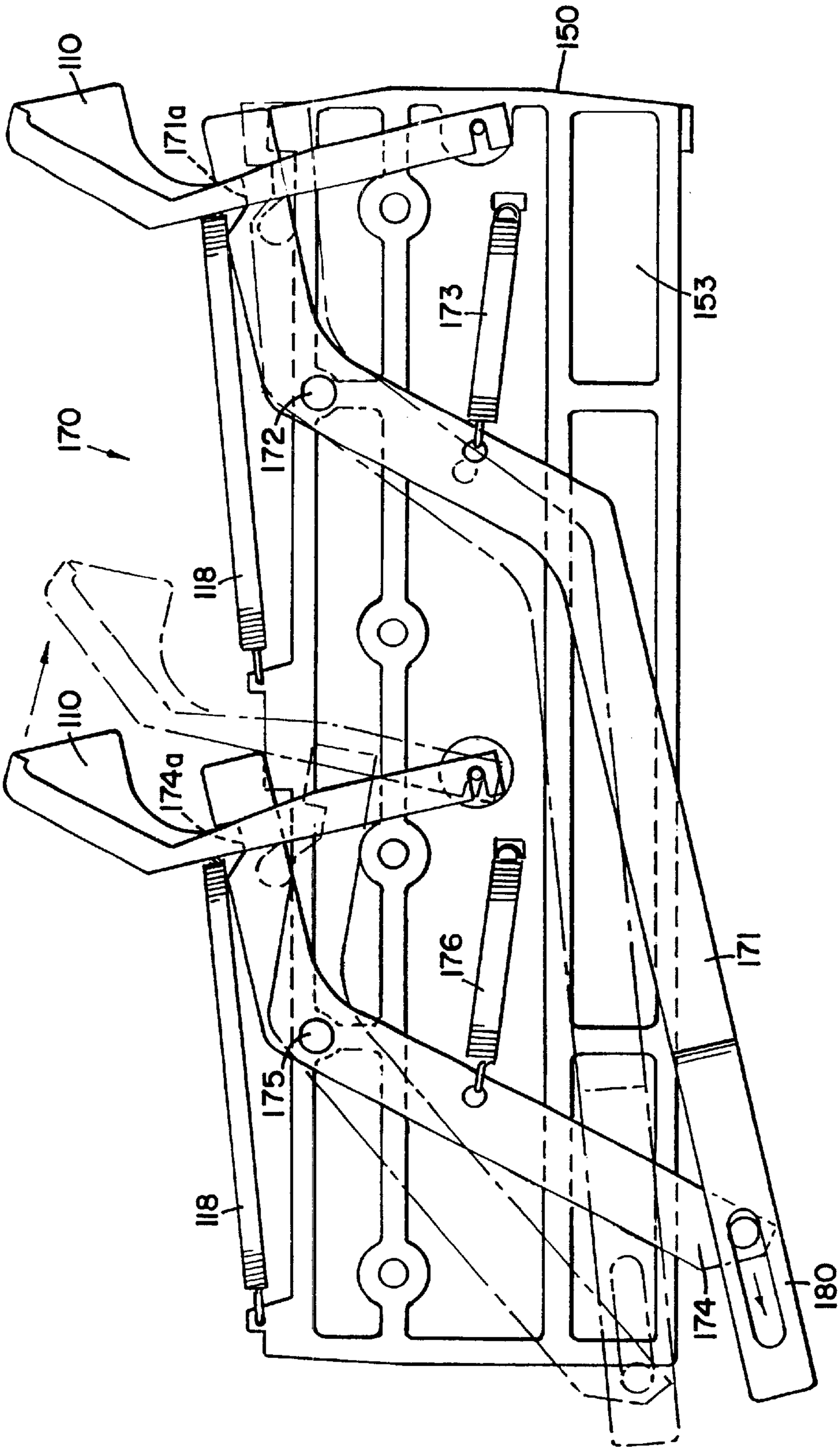


FIG. 23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171a
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174a
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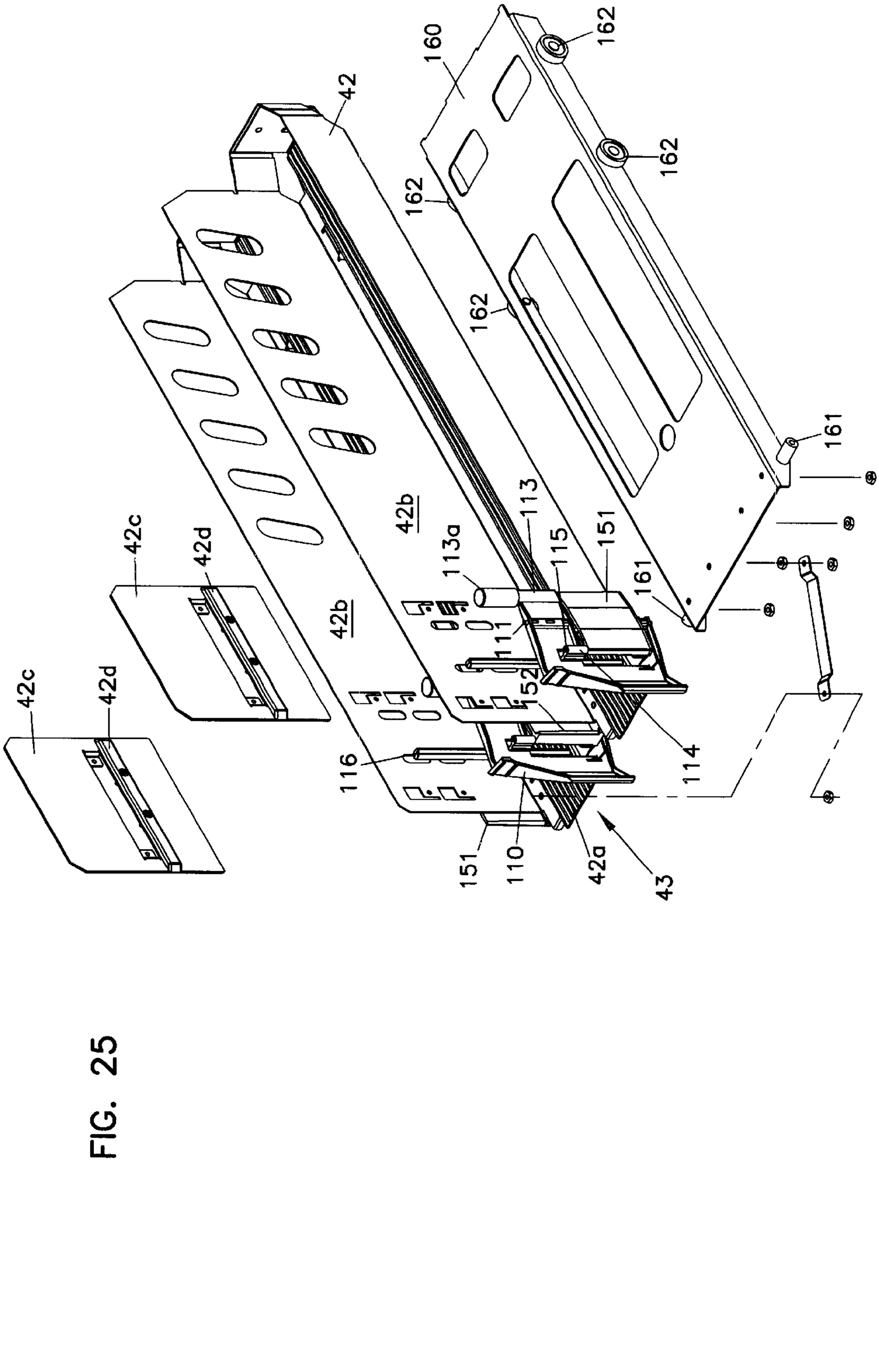
180

FIG. 24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162
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162
162
162
42b
42c
42d
42c
42d
42c
42d
113a
113
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161
111
152
116
114
151
110
42a
43

FIG. 25

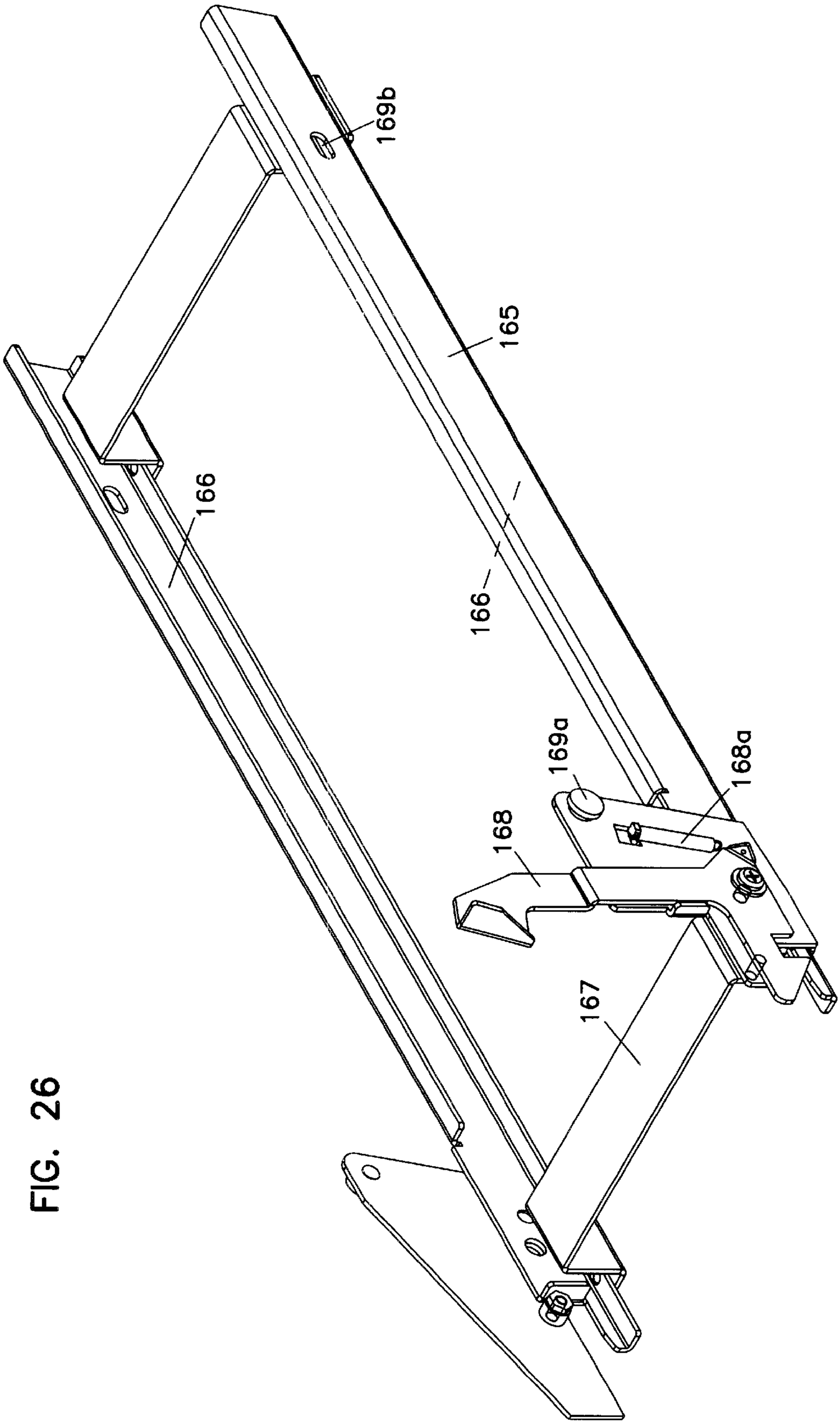


FIG. 26

APPARATUS AND METHOD FOR VENDING PRODUCTS

This is a continuation-in-part application of U.S. patent application having Ser. No. 09/172,556, filed Oct. 14, 1998, now U.S. Pat. No. 6,328,180, which is a continuation-in-part of U.S. patent application having Ser. No. 08/949,366, filed Oct. 14, 1997, now U.S. Pat. No. 6,230,930, the entire disclosures both of which are incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates generally to vending machines, and more particularly to an improved method and apparatus for vending multi-sized and fragile products and in particular bottled or canned beverages of varied sizes and shapes.

BACKGROUND OF THE INVENTION

This invention applies to the vending of products in general and in particular to the difficult issues that arise when attempting to dispense items of various sizes and shapes and/or fragile items that do not fare well when subjected to dropping or impact forces during a vend cycle. While the invention addresses all of these issues, the problems associated with dispensing bottled beverages of various sizes and configurations and packaged in various types of materials such as glass or plastic perhaps best characterize the situation. Accordingly, the invention will hereinafter be discussed in the context of its applicability to dispensing contained beverages, it being understood that the inventive principles can be expanded to include the dispensing of other products as well, such as, for example, fragile potato chips or cookies packaged in sealed cylindrical or tube-like containers.

Machines for vending canned and/or bottled beverages have long been known. Early bottled vending machines enabled release of same-sized bottled beverages, one at a time, following deposit of the required purchase amount, from chest-like coolers. The purchaser was required, for example, to slide the neck of the beverage bottle along and through a retaining race to a dispensing location from which it could be lifted out of the refrigerated chest after release by the dispensing mechanism. With the advent of canned beverages, dispensing became somewhat simpler and easier to automate due to the standardization of container sizes and techniques that enabled the cylindrical cans to roll and drop through chutes during a vend cycle to the delivery area of the machine. Due in part to the rigidity of the cans and their secure seal mechanisms, and the fact that their movement can be fairly well controlled during a dispensing cycle, the canned beverage vending machine has become the standard of today's sealed beverage dispensing systems.

For the most part, the sale of specialty beverages such as fruit or fruit flavored juices, milk, teas and the like, and/or beverages that were sealed in glass or plastic bottles, has been conducted by over-the-counter sale techniques and not through automated vending machines. For many of such specialty beverages, packaging in the standard disposable can configuration is not a viable option. For others, the marketing appeal and distinctiveness of a uniquely shaped or stylized container is of major concern. Non-can packaging has now even become popular for the well-known carbonated beverages, that are readily available in many different sized and shaped containers, both plastic and glass, and in various volumes.

It has also become desirable for vending machines to have glass doors through which the actual product being vended

can be viewed by the purchaser. Such machines having helical vending coils (as for example illustrated in U.S. Pat. No. 4,061,245) for dispensing non-beverage packaged goods have become very popular with both customers and merchants. Refrigerated merchandising coolers for holding bottled beverages and having glass fronts have also been available in, for example, convenience stores, but have not generally been available for automatic dispensing of beverages. Some beverage dispensing machines have been configured such that their front doors hold actual samples of the beverages contained within the machine, but do not display the actual beverages to be dispensed.

Whether or not the vending machine has a glass front, automated vending has been a problem for most of the non-standard sized and non-can beverage containers. To date, an automated vending machine that can reliably and safely vend beverage containers of different materials, sizes and shapes from the same machine, without damaging or dropping the container or product within, has not been available.

One beverage vending machine that has attempted to address the need for a glass front beverage vending machine for bottled-type containers is illustrated in U.S. Pat. No. 5,505,332 and U.S. Pat. No. Des. 362,463. Such a machine enables the purchaser to view and select the actual product to be vended, but operates on a principle that vertically drops the vended beverage container from the front end of the shelf on which it is stored, to a lower chute area that redirects the container to a delivery area from which the purchaser can remove the container. While addressing a number of industry needs, this vending technique is not usable or practical for vending many of the varied shaped and sized beverage containers available today, without the risk of damage to the container or contents. This is particularly true of larger glass bottles or thinner plastic containers that are susceptible to breakage or damage during a vertical drop vending process. In order to address such problems, larger and/or more damage susceptible containers, might be required to be placed on the lowermost shelves of the machine in order to minimize the vertical drop distance. Such requirement can impose significant marketing disadvantages to the merchandisers of such products who may wish to have their products displayed at a higher (e.g. eye level) position in the machine. Further, the impact imparted to the beverage container and its contents as a result of the vertical drop process can result in explosion or ruptured containers. At the very least, for carbonated beverages, the drop vend process requires the purchaser to wait for a period of time before opening the container in order to prevent explosive or overflow effervescence of the beverage upon opening. It is obvious that any breakage or product leakage or explosion within the vending machine can be very detrimental to the operability and reliability of the machine and can contribute to excessive maintenance problems. For non-beverage items such as chips or cookies packaged in tube-like sealed containers, sharp impact forces imparted to the container during a vend cycle can break or crumble the delicate contents of the container.

Another disadvantage of machines such as that of the U.S. Pat. No. 5,505,332 patent, and virtually all vending machines that operate on the principle of dropping and delivering the vended product by gravity, is that the delivery bin or delivery port of the machine is necessarily located below the lowest shelf of the product storage area toward the lower portion of the machine. Such positioning requires the purchaser to bend down and often to reach in awkward manner, in order to retrieve the vended product from the delivery bin of the vending machine.

There have been designs of vending machines that use robotic principles to acquire a product to be vended from the machine. With the use of such robotic techniques, the product to be vended can be selected and removed from its stored position without dropping the product, and which can then be carried to a delivery area that is not required to be at the bottom of the machine. Examples of such machines as applied to the vending of like-sized video cassettes are illustrated by U.S. Pat. Nos. 5,036,472 and 5,139,384. Such systems, however, have not been particularly applicable to the dispensing of fragile products or of beverage containers of varied shapes. In general they have employed robotic mechanisms that are not practical for rapidly dispensing beverage, containers, and do not generally address the other problems of the prior art described above as related to dispensing bottled beverages.

Another difficulty associated with vending containers from ends of product trays in a glass front machine is the requirement of maintaining tight dimensional tolerances at the dispensing ends of the product holding trays so that multiple product vends and/or jamming of product at the dispensing ends of the trays does not occur. This issue becomes even more critical when the product being dispensed has a thinwalled container susceptible to bending or deformation when subjected to vend cycle forces imparted to the product by the vending machine.

The present invention addresses the described deficiencies of prior art vending machines and the need for a dispensing machine and method for dispensing fragile containers such as beverages packaged in glass, plastic or can containers of varied sizes, shapes and fluid volumes.

SUMMARY OF THE INVENTION

This invention provides an improved vending machine apparatus and method for vending products, and particularly bottled and canned beverages and other products packaged in containers of defined geometrical shapes, without subjecting the vended containers to shock and impact forces due to dropping, rolling or abrupt tipping of the product during the vending operation. The invention uses an efficient, cost-effective, highly accurate, reliable and easily programmable robotic beverage capture assembly for capturing that beverage container selected by a customer from a plurality of viewable stored containers and for smoothly, gently, and quickly carrying the captured container to a product delivery area or port of the machine. The product delivery port is located at thigh to waist height to minimize customer bending while retrieving the vended product from the machine. The shelf or tray area of the machine preferably contains no active or powered components, but is entirely passive in nature, being operated entirely in response to activation forces applied thereto by the robotic beverage container capture apparatus. The vending machine and apparatus is extremely versatile and is particularly applicable to the vending of glass and plastic beverage containers of varied sizes, shapes and fluid volumes which can simultaneously be housed and dispensed by the vending machine. The glass door of the vending machine enables point-of-sale marketing of the products to be vended and allows the consumer to view the selected vended product during virtually the entire vend cycle. The smooth vending process minimizes product damage and stress and virtually eliminates machine maintenance caused by damage to or breakage of beverage containers during a vend cycle. The unique machine construction also minimizes changes in critical dimension tolerances at the dispensing ends of the product holding trays, thereby increasing vend reliability and reducing maintenance and repair of the vending machine.

Thus according to one aspect of the invention there is provided a method for vending beverages packaged in sealed containers, comprising the steps of: (a) storing a plurality of packaged beverages and selectable queues of containers of such beverages within a vending machine; (b) aligning a robotic assembly in the machine in registration with a consumer selected one of said beverage container queues; (c) transferring one of the beverage containers from the selected container queue to the robotic assembly; (d) carrying the transferred beverage container to a delivery port of the vending machine; and (e) presenting the carried beverage container at the delivery port for customer removal from the vending machine; wherein the entire process is performed without dropping or subjecting the container to severe impact forces. The product queues can be arranged in vertically spaced columns within the vending machine which can be readily adjusted to accommodate beverage containers of varied heights. Further, the beverages can be arranged on shelves or trays that can be inclined at angles which permit gravity movement of the stored beverages in the queues toward a dispensing end of the queue. According to a preferred aspect of the invention, the customer selected beverage container is transferred from the selected container queue to the robotic assembly by simply sliding the first-in-line container from the selected queue into retaining engagement by the robotic assembly, while retaining the second-in-line and successively aligned ones of the beverage containers in that queue from moving along the queue.

According to yet another aspect of the invention there is provided a method of vending bottled beverages from a vending machine of the type having a transparent front viewing panel that enables customer viewing of the actual beverages held by the machine and available for vending, comprising the steps of: (a) aligning a plurality of bottled beverages in at least two ordered queues of the beverages; (b) providing a customer selection input identifiable with at least one of the two ordered queues of beverages; (c) removing a bottled beverage from said one of said ordered queues in response to said customer selection input; and (d) moving the removed bottled beverage to a delivery port of the machine, wherein the removing and moving steps are smoothly performed without dropping or subjecting the bottled beverage to sharp impact forces.

According to yet another aspect of the invention there is provided a method of vending discrete products from a vending machine of the type having a transparent viewing panel for customer viewing and selection of the products to be vended, and a support for supportably holding the products for visual presentation to a customer through the viewing panel, comprising the steps of: (a) ordering the products in a plurality of selectable queues of the products on the support such that a foremost one of the products in each of the queues addresses the viewing panel at a dispensing end of its associated queue; (b) moving a capture assembly into alignment with a dispensing end of a customer selected one of the queues; (c) transferring the foremost one of the products from the customer selected one of the queues into retainment by the capture assembly; (d) moving the capture assembly with its retained product in view of the viewing panel to a delivery port; and (e) enabling customer removal of the retained product from the capture assembly at the delivery port; wherein the steps of transferring and moving the foremost product from the selected queue to the delivery port are performed without dropping or subjecting the foremost product to sharp impact forces.

According to yet a further aspect of the invention there is provided a vending machine for beverages packaged in

sealed containers, comprising: (a) a storage facility defining an enclosed internal cavity and a container delivery port opening into the internal cavity; (b) a container holder within the internal cavity for holding a plurality of selectable sealed beverage containers, wherein the container holder is disposed to define with the storage facility a vend selection space within the internal cavity; (c) a beverage container capturer for retainably removing one of the plurality of selectable beverage containers from the container holder in response to a vend control signal; (d) transport means operatively connected with the beverage container capturer for moving the beverage container capturer within the vend selection space in response to the vend control signal; and (e) a control system operatively connected with the capturer and with the transport system for producing and providing the vend control signal thereto to cause the capturer and the transport system to cooperatively capture a selected beverage container from the container holder and smoothly carry the captured container through the vend selection space to the delivery port without dropping or subjecting the selected beverage container to sharp impact forces. The invention further contemplates the use of a door forming a part of the chassis and including a transparent panel for enabling customer viewing of the plurality of selectable beverage containers in the chassis. The invention further contemplates the use of container releaser operatively connected with at least one of the queues adjacent its discharge end for selectably retaining the beverage containers in the queue. The container releaser preferably includes only passive components which do not require any external energy sources. The invention further includes a plurality of trays for aligning the containers in their respective queues. According to a further aspect of the invention, the transport system includes a rack and pinion system for moving the beverage container capturer in the vend selection space in an accurate, positive and smooth manner, without vibration or wobble.

According to yet a further aspect of the invention there is provided a vending machine for vending selectable products comprising: (a) a product storage chassis including a door, cooperatively forming an internal cavity, wherein the chassis includes a transparent panel portion to enable viewing therethrough into the internal cavity and a product delivery port spaced from the transport parent panel portion; (b) product selection system operable by a customer for generating a vend control signal indicative a product selection of the customer; (c) a support operatively mounted within the internal cavity of the product storage chassis for supporting the products in a plurality of selectable and separate ordered queues of such products; and (d) a robotic assembly mounted to the chassis and operatively moveable within the internal cavity in response to the vend control signal to rapidly and smoothly remove and carry a selected product from its associated ordered queue to the product delivery port, without dropping or jarring the selected product; wherein a customer can view the entire product removal and carrying operation of a vending cycle of the machine through the transparent panel portion. The invention further contemplates the positioning of the delivery port at a customer convenient height that does not require the customer to excessively bend to retrieve the vended product. According to a further aspect of the invention, a door and associated locking assembly are provided at the delivery port for preventing opening of the door unless a vended product is available at the delivery port, and for preventing movement of the robotic assembly whenever the door is enabled for opening. The invention further contemplates the use of a robotic assembly having an X-Y support frame mounted in the chassis; a shuttle moveably mounted to the support frame for movement therealong in an X-direction; a carriage assembly operatively connected to the shuttle for controlled movement therealong in a Y-direction; and a capture mechanism operatively mounted to the carriage assembly for removing and carrying the selected product from its associated ordered queue. According to a preferred embodiment of the invention, dc motors with output drive gears engaging rack members are used for energizing the robotic assembly.

According to a further aspect of the invention there is provided a carriage assembly for use with the vending machine of the type having: a chassis defining an internal cavity, a front door forming one side of the chassis; a product support assembly mounted in the chassis and configured to hold a plurality of products to be vended in separate ordered queues of the products, such that one end of the queues address a dispensing end of the product support assembly, wherein the volume between the dispensing ends of the product support assembly and the door define a vend selection space; wherein the carriage assembly comprises: (a) an X-rail assembly mounted to the chassis in generally horizontal orientation; (b) a Y-rail assembly mounted to the X-rail assembly in generally vertical orientation and configured for movement along the X-rail assembly; (c) an X-drive motor mounted for movement with the Y-rail assembly for controlling movement of the Y-rail assembly along the X-rail assembly; (d) a carriage mounted to the Y-rail assembly for movement therealong; (e) a Y-drive motor mounted for movement with the carriage for controlling movement of the carriage along the Y-rail assembly; and (f) wherein the carriage assembly is configured to accurately move, position and hold the carriage relative to the product support assembly within the vend selection space. According to a preferred configuration of the carriage assembly, the carriage can attain movement positioning and positional maintenance along the Y-rail assembly to within an accuracy of 1/32 inch and even to within an accuracy of 1/64 inch. Accurate positioning of the carriage assembly in both the X and Y-directions is achieved by position sensors.

According to yet a further aspect of the invention there is provided a product release and capture assembly for use in a vending machine of the type having: a chassis defining an internal cavity; a product support assembly mounted in the chassis and configured to hold a plurality of products to be vended in separate ordered queues of the products, said product support assembly being arranged and configured to define a dispensing end of the queues, wherein a vend selection space is defined in the internal cavity adjacent the dispensing ends of the queues; the product support assembly further including means for urging products in the queues to move toward the dispensing ends of the queues; a carriage; a drive system connected to controllably move the carriage generally in an X-Y coordinate plane within the vend selection space into alignment with the dispensing end of a selected one of the product queues, wherein the product release and capture assembly comprises: (a) an escapement mechanism mounted to the product support assembly of the selected one of the product queues adjacent the dispensing end thereof, wherein the escapement mechanism comprises: (i) a first engagement member configured to selectively engage a first-in-line product at the dispensing end of the selected queue; (ii) a second engagement member configured to selectably engage a second-in-line product aligned in said queue immediately adjacent to and behind the first-in-line product; (iii) a connector operatively connecting the first and second engagement members for cooperative movement, wherein the connector is configured to move the

first engagement member into engaging and disengaging positions relative to the first-in-line product while simultaneously respectively moving the second engagement member into disengaging and engaging positions relative to the second-in-line product; (iv) bias means operatively connected with the connector for normally moving the first engagement member into its engaging position; and (v) a force receiving surface operatively connected with the connector for receiving an activating force tending to move the connector against the normal bias of the bias means; and (b) a capture receptacle movably mounted to the carriage for movement between first and second positions; the said capture receptacle when operable in said first position enabling free movement of the capture receptacle and the carriage relative to the escapement mechanism in the vend space; and being operable when moving to said second position, and when the carriage is positioned in operative alignment with a dispensing end of the selected queue, to engage the force receiving surface to operatively move the connector against the bias of the bias means, to move the first engagement member toward its disengaging position, thereby releasing the first-in-line product for movement out of the dispensing end of the queue and into the capture receptacle. According to yet a further aspect of the invention, the connector slidably engages the first engagement member and the connector and first engagement member are independently pivotally mounted for movement relative to one another. According to yet a further aspect of the invention, the first engagement member extends through a slot in the connector. According to yet a further aspect of the invention, the escapement mechanism includes only passive components requiring no power energy sources. According to yet a further aspect of the invention, the capture receptacle is pivotally mounted to the carriage about a generally horizontal pivot axis and pivotally moves thereabout to activate the escapement mechanism. The capture receptacle includes a floor portion for supporting one of the captured products from the queue and is configured such that its floor portion aligns with the queue floor portion during the vend procedure. The capture receptacle may also include retainer in the floor and a stabilizer for maintaining the captured products in a stable position during its transport phase to the product delivery port.

These and other aspects of the invention will become more apparent upon a description of a preferred embodiment of the invention. It will be appreciated that the preferred embodiment is not to be construed as limiting the invention to any particular configurations, designs, or applications that are specifically presented therein. The preferred embodiment is presented to illustrate a specific application and implementation of the broader principles of the invention and is not to be construed in a limiting manner.

BRIEF DESCRIPTION OF THE DRAWING

Referring to the Drawing where like numerals represent like parts throughout the several views:

FIG. **1** is a front elevational view of a preferred embodiment of a container vending machine incorporating the principles of the invention;

FIG. **2** is an enlarged front elevational view of the inner container tray assembly of the vending machine of FIG. **1**, also illustrating the robotic container capture assembly of the vending machine;

FIG. **3** is a right side elevational view of the tray assembly and robotic container capture assembly of FIG. **2**;

FIG. **4** is a top, right, front perspective view of the support frame structure of the vending machine of FIG. **1** with the outer chassis and door removed, illustrating the robotic container capture assembly attached thereto, and one vertical support beam of the container tray assembly of FIGS. **1** and **2**;

FIG. **5** is an enlarged fractional front elevational view of the upper rail portion of the robotic container capture assembly disclosed in FIGS. **2**, **3**, and **4**;

FIG. **6** is a right elevational view of the upper rail assembly of FIG. **5**;

FIG. **7** is an enlarged fractional front elevational view of the lower rail portion of the robotic container capture assembly disclosed is FIGS. **2**, **3**, and **4**;

FIG. **8** is a cross-sectional view of the lower rail assembly of FIG. **7**, generally taken along the Line **8**—**8** of FIG. **7**;

FIG. **9** is an enlarged fractional perspective view of the container capture cage portion of the robotic container capture assembly of FIGS. **2**, **3**, and **4**;

FIG. **10** is an exploded view of the container capture cage assembly of FIG. **9**;

FIG. **11** is an enlarged fractional perspective view of the front end of a container tray illustrating a preferred configuration of a release mechanism in operative position relative to a beverage container;

FIG. **12** is a diagrammatic side view illustrating movement of the container capture cage portion of the robotic container capture assembly during a vend cycle;

FIG. **13** is a diagrammatic top view illustrating the sequential movement of the container release mechanism during a vend cycle;

FIG. **14** is an enlarged top, front, right side perspective view of the delivery door assembly of the vending machine of FIG. **1**;

FIG. **15** is a top, right, back side perspective view of the door assembly of FIG. **14**;

FIGS. **16**A and **16**B form a schematic diagram illustrating the various components of the vending machine and their functional relationship and interaction;

FIGS. **17**A and **17**B form a flow chart illustrating various operations performed by the vending machine under computer control during a vend cycle;

FIG. **18** is a top perspective view of a floor insert member for use with the container capture cage;

FIG. **19** is a top view of a low surface friction floor insert of a container tray;

FIG. **20** is a cross section end view of the floor insert of FIG. **19**;

FIG. **21** is an enlarged side perspective view of a lever guide arm;

FIG. **22** is a perspective view of a reinforced container release mechanism assembly for a dual container tray configuration;

FIG. **23** is a partial exploded perspective view of the reinforcing yoke portion of the release mechanism assembly of FIG. **22**, also illustrating portions of a lockout assembly;

FIG. **24** is a bottom plan view of the yoke assembly of FIGS. **22** and **23** illustrating a lockout assembly for the container release mechanism;

FIG. **25** is an exploded perspective view of a dual container tray assembly and roller base configured for slidable attachment to a vending machine; and

FIG. **26** is a receptor frame assembly for receiving the roller base member of FIG. **25**.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the figures there is generally illustrated therein a preferred embodiment of a vending machine that

incorporates the principles of this invention. While the preferred embodiment of the invention will be described in association with its applicability to a vending machine for bottled and canned beverages, it will be understood that the broad principles of the invention are not limited to such product dispensing application or to the specifics of the preferred embodiments of the vending machine or its related parts that will be disclosed. The described machine and its respective embodiments represent clear examples of dispensing systems incorporating the principles of the claimed invention, but the invention is not intended to be construed in a limiting manner as a result of the preferred embodiment disclosures.

Referring to the figures, there is generally illustrated at **20** a vending machine for dispensing bottled and canned beverages of varied shapes, sizes, configurations and fluid volumes. The vending machine generally comprises an outer chassis or cabinet **22** and a front hinged door panel **24**, which in combination define an inner cavity **25** for housing the products to be vended, the control and refrigeration functions of the machine and other vending machine features well-known in the art. The front door panel **24** frames a transparent glass or clear plastic panel **26** which provides a clear view into the internal cavity of the cabinet and the beverage products stored in ordered manner on trays therein when the door panel **24** is closed. The door panel **24** includes an appropriate control panel, generally indicated at **28** which includes a product selection input and monetary and credit processing system, well-known in the art. Since the control panel and its various features and functions do not form a part of this invention, they will not be detailed herein. Those skilled in the art will readily recognize many appropriate such control panels and features thereof that could be used in association with a vending machine as hereinafter described. The door panel **24** illustrated in FIG. **1** also includes a coin return slot, generally indicated at **29** and a locking handle assembly **30** that enables the door to be opened and closed in secured manner for purposes of maintenance, loading of the machine, and the like. The door panel **24** also includes a product delivery port, generally indicated at **32**, which is approximately at thigh or waist level and depicted with its door in an "open" position in FIG. **1**, with a vended bottle product **40** illustrated through the open door. A more complete description of the product delivery assembly feature will be hereinafter described.

In the preferred embodiment, the chassis and door panel assembly is supported by a plurality of legs **34** in elevated manner above a floor or support surface to enable ease of cleaning below the machine, the ability to readily lift the machine by a pallet jack, fork lift or other moving type of structure and to provide improved ventilation for a refrigeration system (not illustrated, but well-known to those skilled in the art) for the vending machine. Since the vending machine of the illustrated preferred embodiment is configured to carry beverages, most of which require refrigeration, it is contemplated that the internal cavity (at least that portion thereof which is to contain the beverages to be dispensed) will be refrigerated by an appropriate refrigeration system. Such refrigerated portion of the machine may even be zoned for different temperatures to accommodate vendible products having different cooling needs. The upper product holding portion could also be partitioned into refrigerated and non-refrigerated compartments, into refrigerated and freezer compartments, or in other desired configurations.

The chassis or cabinet **22** of the vending machine is supported by an appropriate internal frame assembly generally illustrated in FIG. **4**. The frame assembly includes a plurality of front and back upright corner support standards **36***a* and **36***b* respectively connected, by upper and lower front and back transverse frame members **37***a* and **37***b* respectively and intermediate front and back transverse members **38***a* and **38***b* respectively. The front and back corner upright support standards **36** and the front and back transverse frame members **37** are interconnected by a plurality of side transverse frame members **39***a* and **39***b* respectively for the left and right sides of the frame structure as viewed from the front of the machine. The frame members **36**, **37**, **38** and **39** collectively define a rectangular frame structure for supporting the chassis and other components of the machine. The refrigeration unit for the machine is generally located in that portion of the internal cavity defined by the framework, and positioned below the intermediate transverse frame members **38**. The product storage portion of the internal cavity defined by the framework is generally located above the intermediate transverse frame members **38**.

The containers housed by the upper portion of the internal cavity of the vending machine **20** are supported by a plurality of container trays, two of which are generally indicated at **42** in FIG. **4**. While the preferred embodiment illustrates container trays for holding beverages, it will be appreciated that the principles of the invention could also be applied to conventional container holding shelf configurations having partitions for separating the containers into ordered rows or aligned queues of containers extending from front to back in the internal cavity. In the preferred embodiment, the trays **42** are mounted to a plurality of vertically oriented tray mounting standards, one of which is illustrated at **44** in FIG. **4**. The vending machine of the preferred embodiment illustrated in FIG. **2**, includes four such vertically oriented tray mounting standards **44**. The tray mounting standard has a pair of vertically oriented and laterally spaced (from front to back) rib members **45***a* and **45***b* respectively. The rib support members **45** are integrally formed with upper and lower support brace portions **46** and **47** respectively that extend in generally horizontal manner in the direction from front to back of the machine. The upper support brace member **46** is secured to an intermediate upper transverse frame member **38** that is mounted between the front and back upper transverse frame members **37***a* and **37***b*. The lower support brace member **47** is fixedly secured to the intermediate front and back transverse frame members **38***a* and **38***b* respectively. The collective support and brace member portions **45–48** which comprise the vertically oriented tray mounting standard **44** form in the preferred embodiment a solid fixed mounting structure for the container trays **42**.

The vertical spaced ribbed support members **45***a* and **45***b* of the tray mounting standard **44** include regularly longitudinally spaced mounting holes (generally indicated at **50**) for mounting the container trays **42** to the tray mounting standard **44**. In the preferred embodiment, the mounting holes **50** are positioned along the rib support members **45** such that successive trays **42** mounted to the rib support members **45** can be positioned at relative spacings that accommodate beverage or other containers of varied heights. In the preferred embodiment, the trays **42** can be mounted along the spaced rib support members **45** so as to accommodate beverage containers held by the trays up to 9 inches in height. Obviously, the relative vertical spacing between the trays **42** and the number of trays mounted to the tray mounting standards **44** is a matter of design and marketing choice. In the preferred embodiment illustrated, the trays **42**

are secured to the rib support members **45** through the mounting holes **50** by mounting clips **52** which enable the trays **42** to be rapidly connected and disconnected from the tray mounting standard **44** when positioning adjustment of the trays **42** is desired. Alternatively, if fixedly secured to the mounting standards, the trays could be fixedly secured to the mounting standards by bolts on other appropriate fasteners. The trays can also be movably mounted to the support standards, as hereinafter described with respect to a further embodiment of the invention. In that preferred embodiment illustrated in FIG. **4**, the vertical alignment of holes **50** in the foremost vertical support rib **45***a* are relatively lower than the corresponding mounting holes **50** in the rearmost vertical rib support member **45***b* such that when a support tray **42** is mounted to the spaced rib support member **45***a* and **45***b*, the tray **42** will be inclined at a downwardly depending angle from back to front of the vending machine to enable beverage containers carried thereby to slide by gravity toward the open front (i.e. dispensing) end of the tray. In the preferred embodiment, the preferred angle of inclination of the tray with the horizontal is from about 8–20 degrees and most preferably about 12 degrees. The degree of inclination is a design parameter that can be varied, depending upon the type, size, weight, configuration, etc. of the container being held, the relative coefficient of friction between the container and the tray floor surface, the type of materials used to construct the tray, the temperature of the internal cavity, etc. It will also be appreciated that the principles of this invention do not require movement of the products toward the dispensing end of their respective trays or shelves to be accomplished entirely by gravity. Other product biasing assist techniques well known in the art could be employed to urge products toward the dispensing ends of the respective trays.

The vertically oriented tray mounting standards **44** are configured to securely support oppositely disposed pairs of container trays **42** as indicated more fully in the frontal view of the tray assembly illustrated in FIG. **2**. It will be appreciated that the foregoing description with respect to the tray mounting assembly of FIG. **4** only illustrates a single tray mounting standard **44** with only several incomplete tray assemblies **42** attached thereto, for ease of description purposes. A more complete tray assembly as it might appear mounted within the vending machine is illustrated in FIG. **2**. Referring thereto, it will be noted that the completed assembly includes four tray mounting standards **44** transversely spaced from one another so as so accommodate two container trays therebetween, with the outermost tray mounting standards **44** being spaced from the upright corner posts **36** of the frame support structure so as to accommodate a single tray width therebetween. While the widths of the trays can vary in the preferred embodiment the product trays can preferably accommodate containers of up to 3 inches in diameter. It will be appreciated that while all of the trays **42** connected to the vertical mounting standards **44** at a particular height are aligned with one another in FIG. **2**, such orientation does not have to be uniform so as to define ordered horizontal rows of products within the machine. In the preferred embodiment illustrated, there are five such rows or shelves of the product trays. Due to the flexible height adjustment capabilities for the trays as provided by the vertically oriented tray mounting standards **44**, each tray can be positioned along its vertical mounting standard at a different height which would accommodate the particular product size and arrangement configuration desired within the machine.

In the preferred embodiment, each of the trays **42** is shaped in the configuration of a U-shaped channel, generally having a lower surface or floor support surface **42***a* and a pair of oppositely disposed side walls **42***b* upwardly extending from the floor **42***a* at right angles with respect thereto. In the preferred embodiment, the side walls are spaced so as to accommodate containers of up to 3 inches in diameter; however, it will be recognized that the invention is not limited by such dimension or to other non-claimed dimensions described herein. The floor **42***a* is designed to minimize sliding friction therealong. The mounting clips or bolts **52** are secured to and/or through the side walls **42***b* of the trays **42** at appropriate longitudinal locations therealong for fastening registry with the mounting holes **50** of the vertical rib support members **45**, as previously described. In the preferred embodiment each of the trays is designed to hold a collective beverage container weight of up to about 20–25 pounds. The beverage trays indicated in FIG. **4** comprise the basic tray element portion of a completed tray, and are illustrated in FIG. **4** without any container release or extended side wall provisions, as will be hereinafter described in more detail. The front or dispensing end of the trays **42** which address the glass door are generally indicated by the numeral **43**. It will be appreciated that other tray or product support configurations such as, for example, wire grid trays could be used.

Containers carried by the plurality of open-faced trays **42** are removed from the trays and transported to the product delivery port **32** by a robotic beverage capture and transport assembly, generally indicated at **60** in FIG. **4**. The robotic assembly **60** operates within the vend selection space **61** (FIG. **3**) which is generally that space or volume between the inner surface of the door **24** and the front surfaces of the front frame members **36***a*, **37***a* and **38***a*. The robotic system will be described with reference to an X, Y, Z coordinate system in the machine. The X-direction is horizontal and parallel to the floor. The Y-direction is the vertical direction and perpendicular to the X-direction. The Z-direction is orthogonal to the XY plane and relative to the vending machine is in the direction from the front to back of the machine. The robotic container capture and transport assembly **60** generally includes a pair of horizontally mounted rail/rack assemblies, a vertically oriented shuttle bar that rides along the horizontal rails in the X-direction, a carrier frame that moves in the Y-(vertical) direction along the shuttle bar, and a pick-up or transfer mechanism that is mounted to and moves with the carrier frame and operates in the Z-direction to remove a beverage container from a selected tray.

The lower rail assembly includes a mounting plate bracket **62** which is secured to and between the front upright corner support standards **36***a* and to the front intermediate transverse frame member **38***a* (FIG. **4**). A lower stationary slide bar **63** is secured, in horizontal manner, to the mounting plate bracket **62** by a plurality of spacers **64**. A lower horizontal gear rack **65** is secured to the mounting plate bracket **62**, generally below and in spaced relationship to the stationary slide bar **63**. An optical X-position indicator plate **66** is mounted to the front corner support standards **36***a* of the frame of the vending machine. The indicator plate **66** has a plurality of markers, generally indicated at **66***a* longitudinally spaced therealong in the X-direction for providing optically detectable position markings for enabling the robotic assembly to align with the columns of trays **42** in the "X" direction. A lower moveable slide bar **67** has a pair of side slide block members **67***a* which define oppositely disposed longitudinal grooves or channels, and which are connected together by a steel mounting plate **67***b* for matingly engaging the upper and lower edges of the stationary

slide bar **63**, enabling the moveable slide bar **67** to cooperatively slide along and be guided by the stationary slide bar **63**.

The upper horizontal rail assembly for guiding movement in the X-direction includes an elongate mounting plate bracket **68** that is secured to the upper front transverse frame member **37***a* of the frame. An upper stationary slide bar **69** is secured, in horizontal manner, to the lower elongated surface of the mounting plate bracket **68** by a plurality of spacers **70**. An elongate upper horizontal gear rack **71** is secured to a lower mounting surface of the upper mounting plate brackets **68** with its gear face addressing the front of the machine. An upper moveable slide bar **72** has a pair of side slide block members **72***a* which define oppositely disposed channels formed therein, connected together by a steel mounting plate **72***b* for matingly slideably engaging the outer edges of the upper stationary slide bar **69**.

In the preferred embodiment, the upper and lower moveable slide bars **72** and **67** respectively comprise a pair of opposed slotted blocks of plastic or acetyl resin material such as that sold under the Delrin® trademark suitable for providing a low-friction slideable bearing surface with the stationary slide bars.

The upper and lower rail assemblies carry a shuttle bar assembly for movement therealong in the X-direction. The shuttle bar assembly has an elongate upright frame member **75** with a lower mounting bracket **75***a* and an upper mounting bracket **75***b*. The lower shuttle bracket **75***a* is secured to the steel plate member **67***b* of the lower moveable slide bar **67**, and the upper shuttle bracket **75***b* is secured to the steel mounting plate portion **72***b* of the upper moveable slide bar **72**. In the preferred embodiment, the upper shuttle bracket **75***b* is channel-shaped in cross-section, as illustrated best in FIG. **6**. This mounting configuration allows the upright shuttle frame member **75** to move in the X-direction as guided by the upper and lower stationary slide bars **69** and **62** respectively.

Movement of the shuttle frame member **75** along the upper and lower slide bars is controlled by an X-drive motor **77**, mounted in vertical manner to the lower shuttle bracket **75***a*. The motor **77** is a reversible dc brush gear motor with a dynamic brake. The dynamic brake enables the motor drive gear to stop immediately when the power to the motor is discontinued, enabling accurate positioning of the shuttle assembly in the X-direction. In the preferred embodiment, the motor **77** is a 24 volt dc motor manufactured by Barber Colman, model LYME 63000-731 rated at 5.3 inch-pounds of torque at 151 rpm, whose output shaft is connected to a drive gear **77***a*. The drive gear **77***a* cooperatively engages a first spur gear **78** which is connected by an elongate shaft **79** to a second spur gear **80** located adjacent the upper rail assembly. The shaft **79** connecting the spur gears **78** and **80** is journaled through appropriate bearings, one of which is shown at **81** in FIG. **6**, which are appropriately mounted to and for movement with the upright shuttle bar frame member **75**. The two spur gears **78** and **80** are commonly rotated by the drive gear **77***a* of the X-drive motor **77**, and rotate about the axis of the elongate drive shaft **79**. The first spur gear **78** cooperatively engages the lower horizontal gear track **65** of the lower rail assembly and moves therealong in the X-direction according to rotation of the drive gear **77***a*. The upper spur gear **80** cooperatively engages the upper horizontal gear track **71** of the upper rail assembly and moves therealong according to rotation of the elongate shaft **79**. Accordingly, the X-drive motor **77** controls movement of the shuttle bar frame **75** and attached components in the X-direction by spur gears **78** and **80** engaging and moving along the upper and lower gear tracks **71** and **65** respectively. Such connection ensures a fixed vertical shuttle attitude as it traverses back and forth in the vend selection space and allows for rapid movement in the X-direction without binding and without wobble or vibration that might be associated with worm gear driven configurations.

The position of the shuttle movement in the X-direction may be monitored and determined in any appropriate desired manner. In the preferred embodiment, an optical sensor **83** (FIGS. **7** and **8**) is mounted to the shuttle frame member **75** and is positioned therealong so as to operatively align with the slots **66***a* in the optical X-position indicator plate **66**. Such mounting enables the optical sensor **83** to detect the position slots **66***a* and to thereby provide X-direction location information back to the robotic motion Controller (as hereinafter described).

A limit switch **84** located at the right end of the lower rail assembly and engagable by the shuttle bar assembly as it moves in the X-direction indicates the rightmost or "Home" position of the shuttle bar assembly in the X-direction. The X Home position represents a location of the robotic assembly that corresponds to a final vend position wherein a captured product is presented at the delivery port **32**, as will be described more hereinafter.

Movement of the robotic beverage capture and transport assembly **60** in the Y-direction is achieved by a carrier frame assembly, generally indicated at **90**, that is connected to and vertically moves along the shuttle bar frame member **75**, as described in more detail hereinafter. A vertically oriented gear rack **91** (see FIG. **3**) is longitudinally mounted along one edge of the elongate shuttle bar frame member **75**. A vertical slide bar **92** (similar in nature to slide bars **63** and **69**) is secured to one side of the vertical gear rack **91** as illustrated in FIG. **3**. The carrier frame assembly **90** is slidably and retainably mounted to and for movement along the vertical slide bar **92** by a moveable front slide block **93** mounted to the carrier frame **90** (see FIG. **2**) and an oppositely disposed movable rear slide block (not illustrated), also mounted to the carrier frame **90**. The front and rear bearing blocks have oppositely disposed grooves formed therein which are cooperatively configured to slidably engage the outer edges of the vertical slide bar **92** in manner similar to that previously described with respect to the upper and lower X-rail assemblies. In the preferred embodiment, the carrier frame assembly **90** also includes an elongate bearing block secured thereto (not illustrated) through which the elongate shaft **79** passes. The bearing block includes a pair of slideable bearings for engaging the outer surface of the shaft **79** as it rotates and as the carrier frame assembly **90** moves therealong in the Y-direction. The bearings of the bearing block need to be capable of handling loads from rotation of the shaft **79** as well as from linear travel along the shaft.

A Y-drive motor **97** having an output drive gear of **97***a* is horizontally mounted to the carrier frame **90** near its upper end, in a manner such that its drive gear **97***a* cooperatively, matingly engages the vertical gear rack **91**. The Y-drive motor **97** is a reversible dc brush gear motor that is driven by a pulse width modulated (PWM) signal. In the preferred embodiment, motor **97** is a 24 volt dc motor manufactured by Barber Colman, model LYME 63070-X-9332. Accurate Y-axis positioning of the carrier frame **90** relative to the shuttle bar assembly and stabilization at any "at rest" position therealong is provided by the pulse width modulation signal. The motor **97** is also provided with an optical pulse encoder **100** that counts the rotations of the motor's shaft. The system Controller, translates the number of rota-

tions information into a linear Y-direction information. This information enables the Controller to determine and control the exact vertical or Y-direction position of the carrier frame **90** relative to the product carrying trays **42** within an accuracy of from 1/32 to 1/64 inch. A limit switch **99** (FIG. **3**) mounted to the side of the shuttle bar upright frame member **75** is positioned to provide a signal to the Controller indicating that the carrier frame assembly **90** is or is not at its "Home" position in the Y-direction. The Y Home position is a Y axis position that enables the carrier frame **90** to move with shuttle assembly **75** in the X direction into the product delivery area.

The carrier frame assembly **90** supports a beverage or container capture assembly that can assume various configurations. For example, the capture assembly may be configured as a robotic arm that grasps and lifts the selected beverage container into the carriage frame assembly. However, in the preferred embodiment, the capture assembly comprises a simple pivotal assembly that rotates in the Z-axis direction to release and capture a container from a customer selected tray **42**. Referring to FIG. **10**, the container capture assembly is generally indicated at **102**. The beverage capture assembly **102** is pivotally mounted to the carrier frame assembly **90** by a pivot hinge member **103** for pivotal rotation about the axis of the hinge **103**. As indicated in FIG. **10**, the capture assembly **102** cooperatively fits and moves into nesting position within the outer shell of the carrier frame assembly **90**. The carrier frame assembly **90** has an open bottom **90***a* and an access port **90***b* formed through its front wall. A Z-drive reversible dc brush gear motor **104** with a dynamic brake, is mounted to the bottom of the beverage capture assembly **102** and has an output drive gear **104***a*. In the preferred embodiment motor **104** is a 24 volt dc motor manufactured by Barber Colman, model JYHE-63200-741 rated at 3.5 inch pounds of torque at 46.6 rpm. A segment of arcuately shaped gear rack **106** is secured to one side wall of the carrier frame assembly **90** and is positioned relative to the position of the drive gear **104***a* such that the drive gear **104***a* cooperatively and matingly engages the teeth of the gear rack segment **106**. When the Z-drive gear motor **104** is energized so as to move the drive gear **104***a* in a clockwise manner (as viewed in FIG. **10**), the lower portion of the container capture assembly **102** moves outward from its first position in nesting engagement with the carrier frame assembly **90** about the pivot axis of the hinge **103** (as indicated in FIG. **12**), to a second or extended position. Reversal of the motor drive, such that the drive gear **104***a* rotates in a counterclockwise direction (as viewed in FIG. **10**) causes the capture assembly **102** to return to its retracted position in nesting engagement with the carrier frame assembly **90**. A pair of limit switches **230** and **229** mounted to the carrier frame assembly **90** indicate respectively when the capture assembly **102** is fully extended or fully retracted (i.e. in its first or second positions). Switch **229** indicates that the capture assembly **102** is fully nested within the carrier frame **90**, whereas switch **230** indicates when the capture assembly **102** is in its fully extended position. The capture assembly **102** includes an access port **102***a* in its front surface that cooperatively aligns with the access port **90***b* of the carrier frame assembly when the two are nested together. Both the carrier frame assembly **90** and the capture assembly **102** have open back surfaces. The capture assembly **102** further includes a pair of tapered container guide members **107** connected to its opposed side walls and tapered in a manner so as to converge toward the front face of the capture assembly for assisting in centering and supporting the outer surface of a container carried by the capture assembly, as will be appreciated more upon further description of the invention. The capture assembly **102** further includes a floor insert member **108** having an upper friction reduced slidable surface similar in nature and material to that of the lower floor portions **42***a,* and a circular detent **108***a* portion formed therein for retaining the bottom edge of a container **40** captured by the capture assembly. The leading edge **109** of the floor insert member **108** may have a tapered, angled, or rounded edge **109***a,* as shown in FIG. **18**, to minimize the likelihood of the foremost portion **110***a* of the lever guide arm **110** and the end of tray **43** from hitting against the insert member **108**. In a preferred embodiment, the floor insert member **108** includes a depressed lip **119** at leading edge **109**, on which the dispensing end of the tray **43** can rest. Floor insert member **108** may be positioned in capture assembly **102** to provide a horizontal surface on which the container rests during transport in the assembly **102**. Alternately, the top surface of floor insert member **108** may be angled to the horizontal. Preferably, the insert member **108** is angled toward the front of the machine so as to tip the top of the container further into the capture assembly **102** to ensure a secure positioning of the container during transport. The capture assembly further includes a transmissive optical sensor, positioned just above the floor insert member. The optical sensor includes a transmitter **223** and a receiver **224** between which an optical signal passes. When the signal is broken by a container received by the capture assembly, a "product present" signal is sent to the system Controller.

The previous description of the container trays **42** described a simple unembellished U-shaped open end beverage delivery tray configuration. In the preferred embodiment, the delivery end portion of the tray has been modified to achieve the vending purposes of this invention.

Referring to FIGS. **2**, **9** and **19**, it will be noted that each of the lower floor portions of the container trays **42** provide an extremely low-friction surface. The low friction property may be achieved by numerous different techniques and materials. In the preferred embodiment the floor insert is approximately 2 inches wide to provide support and stability to the beverage containers carried thereby, although wider and narrower floor inserts **42***a* can be used. In a preferred embodiment the insert material is any one of the acetyl resin materials sold under the Delrin® trademark, including materials known as "industrial grade" or "AF" materials, and materials impregnated or treated with additives such as silicone or fluorochemicals. Materials sold under the Celcon® trademark are also preferred. It will be appreciated that other materials capable of providing a low friction surface can also be used. For example, but not by way of limitation, filled polystyrene or glass thermoplastic composites or bubble construction principles could also be used. Additionally, materials such as polypropylene and nylon, preferably with some surface modifying coating thereon or additive therein, may also be useable. It is preferred that the hardness of the material is sufficiently high so that the weight of bottles or other food items on the floor for an extended time does not distort or deform the floor insert.

In a preferred embodiment, the cross-sectional configuration chosen for the insert **42***a* is a symmetrical ribbed or corrugated configuration wherein the radius of the raised rib portions **141** is in the range of about 0.035 to 0.075 inch, preferably about 0.050 inch, with the height of the rib being in the range of about 0.010 to 0.040, preferably about 0.020 inch, although other dimensions may be used. What is meant by "symmetrical" is that both the top and bottom sides of the floor insert **42***a* have ribs **141** positioned directly opposite

each other, as shown in FIG. **20**. The ribs **141** on the top and bottom sides may or may not have the same geometry. In an alternate embodiment, the ribs on the bottom side may be offset from the ribs on the top side. The thickness of the insert at the land area **143** between the ribs **141** is preferably about 0.04 to 0.06 inch and the overall thickness of the insert (including the land area and the ribs) is preferably about 0.08 to 0.12 inch, more preferably about 0.10 inch. Preferably, the ribs **141** are spaced to provide a land area **143** of about 0.125 inch (⅛th of an inch), although narrower or wider spacing can be used. Eight to 10 ribs **141** across the floor insert **42***a* are preferred to provide proper stability to the bottles. However, the exact design of the floor insert (material selection, rib dimension and spacing, configuration, overall insert width, etc.) can be modified to be best suited for use with the nature and shape of the container being dispensed.

It should be noted that for simplifying the Drawing, the floor insert has not been illustrated in all of the Figures. It will be appreciated that other ratios and other low friction configurations as well as alternate configurations such as wire or rollerfloor configurations could be used. A low-friction tray floor surface is desirable to ensure that the containers being dispensed freely slide by gravity along the floor surface, toward the open dispensing end of the tray. This is particularly true for a tray assembly configuration wherein only the weight of the container and gravity are used to slide the container toward the dispensing end of the tray. The particular surface configuration of the tray floor, in combination with the angle of inclination of the tray are design parameters that can be varied, in view of the nature of the containers that are to be dispensed, in order to provide for optimal movement of the containers along the tray floor surface.

The floor insert **42***a* can be secured in the tray **42** by various methods such as keyholes, screws, snaps, clips, detents, rivets and other mechanisms. Preferably, the attachment mechanism is integrally molded with the floor insert, for example, at the side of the floor insert. A combination of attachment mechanisms can be used. FIG. **19** shows a floor insert **42***a* with keyholes **145** which can be slid over protrusions in the tray **42**, and with side clips **147** which engage with a structure within the tray **42**.

Referring to FIGS. **3**, **9** and **11**, it will be noted that those portions of the tray side walls **42***b* located adjacent the open dispensing end of the trays have been raised or increased in height by extension portions, generally indicated at **42***b*'. Extension portions **42***b'* are shown as generally triangular, but may be of any configuration or dimension. The added height provides for extra stability of the retained container at the tray's outlet end, to minimize sideways or lateral tipping of the container during the dispensing operation. Extension portions **42***b'* may be permanently attached or may be removable and replaceable as needed.

The width spacing between opposed walls **42***b* of the tray can also be varied, either along the entire length of the tray or adjacent the dispensing end **43** of the tray. Adjustability of such interwall width spacing to accommodate containers of varied shapes and diameters is preferably accomplished by removable/replaceable insert wall panel members such as illustrated at **42***c* in FIG. **25**. The wall insert panels **42***c* are configured for detachable slide-on attachment to the primary tray sidewalls **42***b* adjacent the dispensing end **43** of the tray. As illustrated in FIG. **25**, the insert panel **42***c* may include a longitudinally oriented rib extension **42***d* that may be positioned at a height relative to the floor **42***a* of the tray so as to engage an outward projection of a bottle container or the like. The thickness of the rib member determines the effective width dimension of the tray, relative to the size and configuration of the container that will be held by the tray.

In some designs it may be desired to include a reinforcing device on tray **42**. For example, after repeated loading of beverage containers into the tray, the tray may become deformed or lose some of its propensity to return to its original orientation (that is, vertical walls at a 90 degree angle to the floor). A reinforcing clamp or channel may be positioned along the base of the tray **42** to provide support. This or any reinforcement may be removable and replaceable. The need for reinforcement and/or rigidity and dimensional tolerance retention is particularly acute at the front or dispensing end **43** of the tray. It is desirable to maintain the inside spacing dimension between the sidewalls **42***b* of the tray **42** within certain tolerances at a height above the support surface **42***a* that corresponds roughly to the height of the center of gravity of the container being held and dispensed from the tray. Alternatively, where the shape of the retained container is irregular, that height along the sidewalls **42***b* of the tray at which the interwall spacing dimension becomes important is that height along the container surface which engages a sidewall that represents the largest container diameter. That circumferential portion of the container will necessarily apply the greatest lateral forces to the tray sidewall, tending to cause bending and distortion of the sidewall. Such sidewall bending and any accompanying distortion of the container's wall (as can occur with thin-walled containers) can result in a container slipping through the container release apparatus, hereinafter described, or in undesirable forward tipping and/or jamming of the container within the tray or container release apparatus. The required dimensional stability parameters of the interwall spacing will vary depending upon the diameter or width and configuration of the product being dispensed. As an example, however, a maximum wall deflection or interwall dimension variance at the critical height in operative use, of less than or equal to 0.1 inch for a 3 inch diameter container, is preferred. Preferably, such maximum permitted cumulative deflection should be less than about 10 percent of the operative interwall spacing, and more preferably less than about 5 percent of the interwall spacing. It will be understood that such deflection is meant to represent the total cumulative deflection of the walls from their original design positions, including any permanent wall deflection that may occur due to failure of the wall(s) to return to their original positions after a bending deflection (i.e. due to lack of "memory").

Such wall reinforcement may be provided by a reinforcement yoke configuration of cast material such as zinc. One such dual tray yoke configuration is illustrated in FIGS. **22–25**. A reinforcement yoke member **150** configured in the shape of a dual U-channel support has a pair of outer support walls **151** and a central support wall **152** extending upwardly at right angles to a lower base member **153**. The reinforcement yoke is configured to be positioned at and connected to the dispensing ends of two adjacent container trays **42**, such that the opposed sidewalls **42***b* of a tray engage opposing surfaces of an outer support wall **151** and the central support wall **152**, and the lower base member **153** underlies and is secured to the lower support surface **42***a* of the tray. The yoke assembly is constructed of rigid, relatively non-flexing material. Preferably it is of cast configuration of a metal such as zinc that does not require surface finishing or polishing, but could also be machined from a solid piece of metal such as steel. The yoke provides support for relatively thin and bendable sidewalls **42***b* of the container tray, preventing such walls from deflecting in the lateral direction relative to

one another, outside of acceptable deflection tolerances. While the thickness of the yoke material can vary in the preferred embodiment, the nominal wall thickness in non-ribbed areas of a yoke configured to accommodate tray widths of approximately 3 inches, is approximately 0.1 inches. The yoke includes thicker ribbed areas for providing additional structural rigidity and support. While the yoke **150** is illustrated as being configured as an outer support member for the tray sidewalls **42***b,* it will be understood that the yoke, or a structure of similar construction could be used to define and actually act as the tray sidewalls at the dispensing end **43** of the tray. Alternatively, the entire tray construction could be configured in cast or solid (nondeformable) manner. The yoke **150** is also configured to accept and rotatably mount the first hinge pins **111** and second hinge pins **115** of the container release assemblies of the trays, as described more fully below.

The containers carried by a tray **42** are held within the tray and are either prevented or allowed to exit from the open end of the tray by a container release apparatus. In the preferred embodiment, the container release apparatus is entirely "passive" in nature (i.e. does not require any electrical or other energy powered mechanism residing on the trays, for its operation). The container release mechanism is best described with reference to FIGS. **3**, **9**, **11** and **12**. Referring thereto, the container release mechanism includes a primary pivotal lever guide arm **110** which is pivotally connected to the right side wall **42***b* of a tray (as viewed from the open front delivery end of a tray) by a first hinge pin **111**. The first hinge pin **111** and a second hinge pin **115** (later described) are secured by a bracket **112** to the outside surface of the right side wall **42***b* of the tray (as shown in FIG. **3**) and have their operable mounting portions extending upwardly above the upper edge of the right side wall. The lever guide arm **110** is secured to such upwardly projecting portion of hinge **111**. The hinge pin **111** connection to the tray side wall is positioned such that the portion of the lever guide arm **110** that is located "forward" of the hinge pin **111** has a front portion thereof that extends outward, beyond the front edge of the tray floor. The foremost portion **110***a* of the lever guide arm **110** is bifurcated and bent at two angles to the general plane of the lever guide arm to form a pair of forward cam surfaces. The angled cam surfaces provide a broad "target" area for engagement and activation by movement of the container capture assembly **102**, as hereinafter described. The lowermost of the cam surfaces extends slightly below the floor of the tray. In a preferred embodiment shown in FIG. **21**, the lowermost surface extends below the floor and includes another section **110***c* extending rearward through the hinge pin **111** (position shown in dashed lines), so as to provide a "c" shaped surface. This extension **110***c* increases the overall strength and rigidity of the guide arm **110**. The guide arm **110** may include any other designs to provide the desired structural features. The rearmost portion of the lever guide arm **110** is pivotable about the hinge **111** toward the open portion of the tray **42** with which it is associated (i.e. away from the side wall **42***b*) and retainably holds a first container engaging rod member **113** that is oriented generally perpendicular to the lower floor **42***a* and generally parallel to the side walls **42***b* of the tray **42**. The height of the container engaging rod member **113** can vary to accommodate different heights of containers. The lower edge of the rod member **113** is carried by the lever guide arm **110** in spaced relation to the tray floor and floor insert members. The purpose of the container engaging rod member **113**, as will become clear upon a more detailed description, is to engage a container in the tray and prevent its sliding movement along the tray in the direction toward its dispensing end.

That portion of the lever guide arm **110** located forward of the hinge pin **111** also includes a slot passageway **110***b* formed therethrough for slidably accommodating a second lever arm **114** that is pivotally mounted to the right side wall **42***b* for movement about the second hinge pin **115**. The second hinge pin **115** is mounted by the bracket **112** adjacent the forward edge of the right side wall **42***b,* as indicated in FIGS. **3**, **9** and **11**. The second lever arm **114** extends through the slot **110***b* to a distal end which retainably holds a second container engaging rod member **116** which is similar in nature to that of the first container engaging rod member **113**, and serves the same general purpose (i.e. to block movement of a container along the floor of the tray). The slot **110***b* in the lever guide arm **110** is strategically positioned relative to the hinge pin **115** and its attached lever arm **114** such that when the lever guide arm **110** is positioned in its normal position as illustrated in FIG. **11**, the "forward" edge of the slot **110***b* will engage the forward face of the second lever arm **114** to cause the second lever arm **114** to project outwardly and generally perpendicularly, laterally across the tray **42** so as to position the second container engaging rod member **116** held thereby directly in the path of the first-in-line container, preventing that container from advancing out of the open end of the tray. It will be noted that when in such normal position, the broad surface area portion of the forward face of the second lever arm engages the forward edge of the slot **110***b* at a right angle to the edge material (i.e. to the general plane of the lever guide arm **110**) such that the slot edge provides maximum leverage to the second lever arm **114** in such position. It is important that the pivotal guide arm **110** and associated components such as the container engaging members **113**, **116** and the second lever arm **14** be configured of rigid, durable materials that do not deform when subjected to operative stress forces and which retain their shapes and properties under repetitive and extreme use conditions. It has been found that casting such members from materials such as zinc provides the desired rigidity and material properties sought in this application. Such cast parts are preferable to thinner, less rigid plate materials such as steel or to more expensive machined parts. Further, casting materials such as zinc are preferred to those such as aluminum which require expensive finishing steps to provide the desired smooth surfaces preferred for such parts. These parts may all be used in combination with and mounted to a cast reinforced yoke assembly such as **150**, previously described. This situation is illustrated in FIG. **11**. In one embodiment, it may be desired to include a dimple or other type of protrusion on second lever arm **114** to increase the resistance to the advancement of the beverage container. This protrusion is preferably positioned near slot **110***b,* and functions by increasing the force necessary to move lever guide arm **110** in relation to second lever arm **114**. The second beverage engaging member **116** need not be positioned in the center of the tray to accomplish its purposes. It need only engage the beverage container along its outer circumference at a position there along such that the forwardmost edge of the container does not project out beyond the front edge of the tray. The primary pivotal lever guide arm **110** is held in this "container engaging" position by a spring **118** transversely extending below the front edge of the tray, secured between the forward edge of the left side wall **42***b* or floor of a tray and a forward portion of the lever guide arm **110**. It will be noted that when the primary lever arm is positioned in it's "normal" position, the spring **118** holds the general plane of the forward portion of the lever

arm **110** slightly spaced from the side wall **42***b,* by the distance "d" as illustrated in FIG. **11**, to prevent pivotal motion of lever **114**. When the rod member **116** is in such container engaging position (FIG. **11**), the rearmost portion of the lever guide arm **110** and its associated first container engaging rod member **113** will be positioned in resting engagement against the right side wall **42***b* of the tray so as to allow passage of containers along the tray lower surface and toward the open end thereof.

This is the "normal", "unactivated" mode of operation of the container release apparatus. The slot **110***b,* lever arm **114**, engagement member, pivotal travel of the lever guide arm **110** about its hinge **111**, and tension of the spring **118** are collectively and cooperatively designed such that the forces applied to the engagement member **116** by a full tray of containers as a result of their collective weight vectors in the (-Z) direction (i.e. toward the open end of the tray) will not cause the first or second lever arms **110** or **114** to pivot about their axes in a container releasing direction (counterclockwise when viewed from above). In such position, the lever arm **114** will be prevented from rotating by the forces applied to it by engagement with the slot **110***b* of the first lever arm.

When an activating force, in a Z-direction toward the open face of the tray and from external thereof, is applied to the forward cam surface of the foremost portion **110***a* of the lever guide arm **110**, such cam activating force causes the lever guide arm **110** to pivot (in a counterclockwise direction as viewed from above) about its hinge pin **111** against the bias of spring **118**. Such pivotal action causes the rearward portion of the primary lever arm to rotate in counterclockwise direction about hinge **111**, moving the first container engaging rod member **113** into the advancing path of a second-in-line advancing container, and forces the forward portion of the lever guide arm to pivot **110** into resting engagement with the right side wall **42***b* of the tray. As the lever guide arm **110** rotates about the hinge pin **111**, the forward portion of the lever guide arm will "slide" to the right as viewed from the front of the machine, against the second lever arm **114** by reason of the slot **110***b,* until the lever guide arm **110** is in resting engagement against the right side wall **42***b*. As such sliding motion occurs, the lever guide arm **110**, through its slot **110***b,* will no longer retard pivotal movement of the second lever arm, and the second lever arm **114** will pivot, as a result of forces applied to it by the first-in-line container engaging its beverage engaging rod member **116**, in a counterclockwise direction as viewed from above, about the second hinge pin **115**, until the second lever arm **114** rests generally parallel to and alongside the lever guide arm **110**. At that position the second container engaging rod member **116** will lie in resting engagement against the forward portion of the lever guide arm **110**, allowing the first-in-line container to freely slide by gravity out of the open end of the tray **42**. At the same time, the first container engaging rod member prevents sliding motion of the second-in-line container and all containers behind it, from sliding down the tray. This process is further described in more detail hereinafter in relation to a "vend cycle" and FIGS. **12** and **13**.

When the "activating" pressure against the forward cam surface of the foremost portion **110***a* of the lever guide arm **110** is released, bias of the spring **118** against the forward portion **110***a* of the guide arm **110** will cause the lever guide arm **110** to return to its normal position by pivoting in a clockwise direction (as viewed from above) around its hinge pin **111**. Such pivotal action will cause the wall of the slot **110***b* in the lever guide arm **110** to apply pressure against the second lever arm **114**, rotating the second lever arm **114** about its pivot hinge **115**, which in turn will move the second engaging rod member **116** back to its "blocking" position near the front of the tray. During this "return" procedure, there are no forces from containers being applied to the lever arm **114**, since the first container engaging rod member **113** is holding back the containers remaining in the tray. However, as the rod member **116** is returning to its blocking position, the rod member **113** is simultaneously returning to its normal position alongside the side wall **42***b*. The "return to normal" cycle time is fast enough so as to allow the lever **114** and its associated rod **116** to return to their normal positions before the containers released by the rear rod **113** slide into advancing engagement with the rod **116**.

Referring to FIG. **1**, the product delivery port **32** has associated therewith an automated delivery door opening and closing assembly, illustrated in FIGS. **14** and **15**. As indicated above the product delivery port is preferably located between thigh and waist level so that the customer does not have to unduly bend to retrieve the vended product therefrom. In a preferred configuration, the height of the delivery port is at least 27 inches from the floor and more preferably at a height of 30 inches or more. FIG. **14** illustrates the door opening assembly **120** as it would be viewed from the front right side of the vending machine, and FIG. **15** illustrates the door opening assembly as it would appear from its right back position. The door opening assembly **120** generally has a front mounting plate **121** defining an access port **121** a therethrough which cooperatively aligns with the product delivery port **32** formed in the front panel of the vending machine door **24**. The door opening assembly **120** also has top and right side wall portions **122***a* and **122***b* respectively, but does not have a left side panel. The open left side enables the moveable carrier frame assembly **90** and its mating container capture assembly **102** to move into cooperative docking alignment with the door opening assembly **120** such that the access port **121***a* of the door opening assembly operatively aligns with the access port **90***b* of the carrier frame assembly **90** and the access port **102***a* as the container capture assembly **102** at the end of a vending cycle. This position also correspond to the X Home and Y Home positions. A reversible electric motor **123** having an output drive gear **123***a* is mounted to the right side panel **122***b* of the door opening assembly. The door opening assembly **120** further includes a slidable door panel **125** that is mounted for sliding movement in the vertical direction. The left side (as viewed from the front) of the door panel **125** slides within a channel **126**. The right side of the door panel **125** is integrally connected with a gear track extension **127** that rides within a retaining channel (generally indicated at **128**) of the door opening assembly. The output drive gear **123***a* of the electric motor **123** is positioned to engage the gears of the gear track extension **127** through an opening **128***a* in the right side channel **128**. As the electric motor **123** is energized, the output drive gear **123***a* rotates to move the engaged rear track extension so as to raise and lower the slidable door panel **125**. The door panel is illustrated in its lowered position in FIGS. **14** and **15**. A pair of limit switches **130** and **131** are mounted to the right side wall **122***b* of the door opening assembly **120** for respectively detecting the raised (closed) and lowered (open) positions of the door panel **125**. The gear driven door configuration provides a secure door:opening mechanism that is not easily pried open by vandals or thieves when in a closed position. The product delivery port also has associated therewith a security lock system for locking the carriage frame assembly **90** in its docked position at the

product delivery port at the end of a vend cycle. Such locking prevents unauthorized or vandalous entry into the interior of the vending machine through the product delivery port when the delivery door is open. The security locking apparatus generally includes a motorized lock, indicated generally at **218** in FIG. **1**, a sensor **216** for detecting a locked status and a sensor **217** for detecting an unlocked status. Those skilled in the art will appreciate that such locking apparatus can assume many mechanical configurations, the details of any one of which are not limiting to the scope of this invention. Further, while a particular configuration of a vertically movable door has been described, those skilled in the art will appreciate that other configurations, as for example, rotatable door panels can also be used.

Although mounting of the trays **42** to the tray mounting standards **44** has been illustrated in FIGS. **2–4** as being fixed, an alternative tray mounting configuration enables one or more of the trays to be mounted in a manner such that they can be slid forward for ease of loading containers into the trays. One such embodiment of a movable tray mounting configuration is illustrated in FIGS. **25** and **26**.

Referring thereto, the movable tray assembly is configured to mount two container trays **42** in side-by-side slidable relationship with respect to the vertical rib standards **45** of the vending machines internal frame structure. The dual tray assembly is also illustrated in combination with a reinforcing support yoke **150** as previously described. Use of such a reinforcement yoke at the dispensing ends **43** of the trays becomes more significant since in a movable tray structure, the dispensing ends of the trays are not directly structurally supported by the vending machine frame assembly when the trays are pulled outwardly from the machine, and are at such instances particularly susceptible to damaging bending forces being applied to the tray's sidewalls.

Referring to FIG. **25**, the yoke support structure **150** is secured to the pair of container trays **42** at their dispensing ends **43**, as previously described. For added stability and reduced maintenance, the respective assemblies comprising the pivotal guide arm **110** and the first container engaging member **113** are formed from a single case piece of material that is pivotally mounted by hinge pin **111** to the yoke **150**. In FIG. **25**, an extension member **113***a* has been attached to the first container engaging member **113**. The second lever arm **114** and attached second container engaging member **116** are also formed from a single cast piece of material and are pivotally secured by hinge pin **115** to the underlying yoke **150**. All cast parts in the preferred embodiment are of maintenance free zinc material, and collectively form a very stable container release mechanism at the dispensing ends of the trays.

The bottoms of the trays **42** with yoke and container release mechanisms are mounted to a roller base assembly **160**. The base assembly includes a pair of outwardly projecting pins **161** adjacent the front or forward end of the base, and four rollers **162** along the opposite outer rear edges of the base. The pins **161** are used to accurately guide the base into alignment with the vertical rib frame standards as the base and attached trays are slid into the vending machine, and are used to anchor or fix the base and tray assembly into operation position within the vending machine.

A receptor frame assembly **165** (FIG. **26**) is fixedly secured between two adjacent vertical frame mounting standards **44**. The receptor frame defines a pair of outer races or channels **166** running along its opposite longitudinal sides, sized and configured to matingly accept the rollers **162** of the roller base assembly **160** in manner similar to a typical drawer slide configuration. A stop member **167** projects across each of the channels at a position near the front of the receptor frame, to engage the roller base **160** and limit the forward motion of the base assembly relative to the receptor frame. In the preferred embodiment such motion is limited such that the pair of container trays **42** can be pulled out from the vending machine frame to a distance of about ½ their length, for loading/unloading of containers. The receptor frame has a trip lever **168** with biasing spring **168***a* on one side adjacent one the forward end thereof, positioned to matably engage and retain one of the alignment pins **161** of the roller base tray **160**. When the trip lever retainably engages the alignment pin **161**, the roller base assembly and attached pair of container trays is held and maintained in operative position within the vending machine. Movement of the trip lever against its spring bias enables the roller base assembly and attached trays to be pulled out as guided by the channels **166** and rollers **162** to their loading position. The receptor frame **75** configured to be fixedly secured to the support standards **44** of the vending machine by mounting members such as illustrated at **169***a* and **169***b* in FIG. **26**.

A lockout assembly **170**, mounted to the bottom of the base **153** of the support yoke **150**, prevents operative movement of the container release mechanism at the dispensing ends of the trays when the trays are positioned in a forward or extended position relative to the vending machine. The lockout assembly **170** is illustrated in FIG. **24** which portrays a bottom plan view of the yoke **150** and attached lockout assembly. The lockout assembly includes a primary lever actuator arm **171** pivotally mounted to the yoke base **153** by the pivot pin **172**. The actuator arm **171** rotates in a counter clockwise direction under the bias of a spring **173** to the solid-line position illustrated in FIG. **24** when the roller base and tray assembly is moved in the withdrawn (slideout) direction form the vending machine. A second actuator arm **174** pivots about pin **175** and has a first end that slidably reciprocates within a first end of actuator lever **171**. Second actuator lever **174** rotates in a counterclockwise direction under bias of a spring **176**. Each of the actuators **171** and **174** has a notch **171***a* and **174***a* respectively adjacent their second ends that is positioned to engage and control movement of one of the pair of pivotal guide arms **110** of the container release mechanism. When the roller base and tray assembly is positioned in an extended position, the first and second actuator arms **171** and **174** will cooperatively engage (via their notches **171***a* and **174***a*) the pair of pivotal guide arms to prevent operative movement of the guide arms, as shown in bold lines in FIG. **24**. When so locked, the guide arms **110** can not be operated to release containers from their respective trays. As the roller base and tray assembly is moved back into the vending machine, a forward cam surface **180** near the first end of actuator lever **171** will engage one of the vertical support standards **44**, causing the first and second actuator arms **171** and **174** to rotate in clockwise directions to the positions illustrated in dashed lines in FIG. **24**. The rotation will be complete when the tray assemblies have been completely inserted into the vending machine and have been locked in operative position by the trip lever **168**. This position, the locking assembly is positioned in an unlocked orientation, with the notches **171***a* and **174***a* of levers **171** and **174** disengaged from guide bars **110**, allowing guide bars **110** to pivotally move in normal manner as illustrated by the dashed lines for the leftmost guide bar of FIG. **24**.

The above tray mounting configuration enables servicing and loading of containers into selected ones or pairs of trays

without having to pull out an entire shelf or vertical column of trays that could cause dangerous instability conditions due to the significant cantilevered weight that could be present on such shelves or vertical columns when fully loaded with containers. Further, by limiting the outward travel of the dual movable trays to about ½ of their respective lengths, the bending or deforming forces applied to any slidable tray combination is significantly reduced.

FIGS. **16**A and **16**B generally illustrate the various electronic and control functions and components of the vending machine and their functional relationship and interaction to one another. FIG. **16** is not intended to be exhaustive of all functional and electronic details of the machine, but is a general overview of the major functions. The primary functions of such machines are well-known in the art and will not be detailed herein, since they do not form a part of the invention. It is well within the province of one skilled in the art to configure a vending machine in the proper format configuration and under proper control for which it is intended to serve. Accordingly, it is not believed necessary to further belabor such generalities in this application. In general, a Controller **200** provides all centralized control functions for the vending machine. A Controller could be in the nature of a computer or a microcontroller with embedded code, having a central processing unit through which all functions in the machine can be programmed controlled and coordinated. Such a central processing unit would include such things as a main program stored in memory that operates in connection with a plurality of other files such as utility files, screen picture files, screen voice files, product data files, sales report files, documentation files, robotic path files, and the like—generally-known to those skilled in the art. In a typical machine, the Controller **200** is coupled to a power supply **201** upon which it depends for its own energization, and may control the application of power from the power supply to other functions throughout the system. In this regard, it should be noted that while various electrical components have been disclosed in describing the preferred embodiment, no power connections have been illustrated as associated with those components, it being understood that appropriate power connections are provided in the operative machine. The power supply **201** is also connected to provide various lighting functions **(202)** required in the machine. The Controller **200** is also connected to operator input means, generally designated as a keyboard **203**, which can represent both a service keyboard for programming and entering information into the Controller as well as the product selection keys or pads located on the front of the machine. Controller **200** also operates various other customer interface features such as a display panel **204**, possibly a speaker **205**, and appropriate credit interface networks, generally represented at **206**. The credit interface function **206** communicates with such peripheral systems as bill validators **207** a coin mechanism **208** and a debit card network **209**. Controller **200** also controls the refrigeration functions **210** which include communication with and control of such ancillary functions as temperature sensors **211** and the compressor **212** and fan **213** which are typically operated through a compressor relay **214**.

The Controller **200** controls the security lockout functions previously described for locking the carriage frame assembly **90** at the product delivery port following a vend cycle, generally indicated at **215**. The security lockout function includes communication with the locked sensor **216**, the unlocked sensor **217** and the locking motor **218**.

The Controller **200** also communicates with and controls the functions associated with the operation of the delivery door (functional block **220**) and the various functions of the robotic beverage capture and transporting functions. The delivery door function, includes communication with the door open and door closed limit switches **131** and **130** respectively and the door control motor **123**. The product present sensor function of the transmissive optical sensor **222** mounted in the beverage capture assembly **102** communicates with the Controller **200**. The transmitted and receiver portions of the product sensor are indicated at **223** and **224** in FIG. **16**A. The X, Y and Z-direction control functions, generally indicated at **225**, **226** and **227** respectively are coordinated through a delivery head control network **228** which communicates with Controller **200**. The X-direction control function communicates with the X-Home switch **84**, the X-drive motor and brake **77** and the X-position optical sensor **83**. The Y-direction control function **226** involves communication with the Y-motor optical encoder **100**, the Y-Home switch **99** and the Y-drive motor **97**. The Z-direction control function **227** communicates with the Z-in and Z-out switches **229** and **230** respectively mounted on the carrier frame assembly **90** for detecting pivotal motion of the container capture assembly **102** and the Z-drive motor and brake **104**.

In operation, the plurality of trays **42** within the vending machine are adjusted relative to their associated support tray mounting standards **44** to accommodate the relative heights of the products desired to be vended. The trays are then loaded with the desired containers through the open door **24**. The loaded containers are retained in ordered manner on their respective trays by the container release mechanisms previously discussed, at the forward ends of the trays. In general, the machine has two modes of operation, a"Service" mode which is entered whenever the door **24** is open and will not be discussed herein. The normal mode of operation is the "Operate" mode and is the one which is of general concern to this invention. Upon entering the "Operate" mode a diagnostic check is performed on the vending mechanism. If the diagnostic check fails, the Controller **200** takes the unit out of service and displays an appropriate "Out-of-Service" message on its display panel **204**.

After a power-up or reset condition, the Controller goes through a startup sequence which energizes the various functional peripherals of the system. In an idle state, the external display of the machine will show the accumulated credit amount when no keypad or vend activity is present. If there is still a container or product in the delivery bin of the machine an appropriate message such as "PLEASE REMOVE PRODUCT" will be flashed continuously until the product is removed. Keypad depressions and credit accumulation is disabled if a product is still in the delivery bin. The carriage frame assembly **90** will be locked in its docked position at the product delivery position. The credit accumulation, credit acceptance and the handling of cash, bills and tokens is similar to that of other vending machines and is well-known in the art.

The process of initializing a "Vend Process" is illustrated in the flowchart of FIGS. **17**A and **17**B. Referring thereto, following the start-up sequence **300**, generally described above, the Controller continually looks to see if a keypad entry or selection has been made **(301)**. When a selection is entered on the keypad, the Controller will determine **(302)** whether sufficient credit is available for the given selection. If the accumulated credit is greater than or equal to the selection price, a vend attempt will be made for that selection. During this time, the customer's selection will also be shown on the display panel. If the credit accumulated is less than the selection price, the price will be flashed for three

seconds or until a new selection key is pressed. Also, if the level of the coin changer assembly's least value coin tube is below its lowest sensor, the "Use Correct Change" sign will be continuously illuminated.

Assuming that proper credit has been accumulated for the selected product, the Controller will ensure that the container capture assembly **102** is empty **(303)**. If the container capture assembly **102** still contains a container, the Controller will not allow the vend cycle to continue until the container has been removed from the capture mechanism. The Controller then checks to see if the delivery door **125** is positioned in a closed position (decision block **304**). If the door is open, the Controller will not allow the vend cycle to proceed.

If both the conditions of an empty container capture assembly and a closed delivery door are satisfied, the vend cycle proceeds and the security lock motor **218** is energized to unlock the carriage frame assembly **90** for movement **(305)**. Once unlocked, the shuttle bar assembly **75** is enabled for movement in the X-direction, and Pulse Width Modulated (PWM) signals are sent to the Y-drive motor **97** to move the carrier frame assembly **90** slightly up, in the Y-direction, to a "hovering" position just above the Home seated area so that the Y-home switch **99** is activated **(306)**. This allows the carriage frame assembly **90** to clear the product delivery area when it begins moving with the shuttle assembly **75** in the X-direction. The carrier frame assembly **90** is held at its hovering Y-position **(307)** and the shuttle bar assembly is moved in the left X-direction to its first position as detected by the optical column position sensor **83** and the associated optical position indicator plate **66 (308)**. In the preferred embodiment the "first" X-position is the position in alignment with the right most column of trays in the vending machine, just left of the control panel as viewed in FIG. **1**.

The controller then energized both the X and Y drive motors **77** and **97** so as to position the carriage frame assembly **90** in operative position in front of the customer selected tray **42**. The particular tray column position (in the X-direction) is sensed by the optical sensor **83** and its associated position indicator plate **66**. The desired amount of travel in the Y-direction is determined by the optical encoder **100** associated with the Y-drive motor **97**, which counts the revolutions of output shaft movement when the Y-drive motor is running. These functions are indicated by block **309** in FIG. **17**B. When the carrier frame assembly **90** reaches the desired Y-direction position, its movement is stabilized by the PWM drive signal **(310)**, which maintains the carriage frame assembly at the desired Y-direction height. As described above, the PWM Y-motor control feature can enable accurate positioning of the carriage frame assembly relative to the selected tray within 1/32 to 1/64 of an inch.

When the carriage frame assembly **90** is properly positioned before the customer selected tray, the Z-drive motor **104** is energized to rotate the container capture assembly **102** relative to the carrier frame assembly **90** until the limit switch **230** indicates full rotated extension of the container capture assembly **102 (311)**. As the container capture assembly arcuately moves toward the selected tray **42**, the forward edge thereof engages the forward cam surface **110***a* of the foremost portion of the lever guide arm **110** on the selected shelf. As the container capture assembly continues to rotate in the forward direction, the lever guide arm **110** is rotated thereby about its hinge pin **111**, causing the second lever arm **114** to rotate in a counterclockwise direction (as viewed from above), moving the container engaging rod member **116** out of engagement with the foremost (first-in-line) container on the selected tray. Simultaneously, the rearmost container engaging rod member **113** is moved into blocking position in front of the second-in-line container, preventing the second-in-line container from progressing down the inclined selected tray. Once the rod member **116** is removed from retaining contact with the first-in-line container, the first-in-line container is permitted to slide by gravity out of the open end of the selected tray and into the rotated container capture assembly **102** which is now in direct alignment with the selected container tray. It should be noted that when the container capture assembly **102** is fully rotated by the Z-drive motor **104**, as indicated by activation of the Z-out switch **230**, the upper surface of the floor insert member **108** of the container capture assembly **102** will be co-planarly aligned with the upper surface of the lower floor insert **42***a* of the selected container tray **42** so as to form a continuous sliding surface for the first-in-line container to slide from the open end of the selected tray and into the aligned container capture assembly **102** (see FIG. **12**). As the first-in-line container slides into the container capture assembly, its lower surface will enter the circular detent portion **108***a* of the floor insert member, further retaining the container in fixed placed within the capture assembly. The upper portion of the captured container will engage the tapered container guides **107** to add further balancing support to the captured container within the container capture assembly. At this position, the captured container will also activate the product present sensor **222** within the container capture assembly, indicating that the selected first-in-line container actually has been dispensed from the selected tray and has been captured by the container capture assembly **102**. As long as the container capture assembly **102** remains in its Z-out receiving position, its engagement with the primary pivotal lever guide arm **110** will maintain the guide arm at its activated/rotated position against the bias of the spring **118**, maintaining the second container engaging rod member **116** in front of the second-in-line container, to prevent its movement along the lower surface of the selected tray.

Referring back to FIG. **17**B, after the Z-out switch **230** has been activated **(311)**, the Controller will wait for one second for the selected first in-line container to slide into the container capture assembly **(312)**. The Controller then interrogates the product present sensor **222** to see if the container capture assembly **102** has actually received the selected container (decision block **313**). If the container capture assembly **102** is empty, the Controller repeats this process for up to three times. If the container capture assembly **102** remains empty after three cycles through its box **313** check, the Controller assumes that the selected tray is empty and flashes a "Sold Out" signal on the vending machine display. If this condition occurs, the Z-motor is energized to return the container capture assembly into the carriage frame assembly, the X and Y motors are energized to return the carriage frame assembly to its Home position, and the customer's money is refunded, ending the Vend cycle.

If the product present sensor **222** indicates that a container has in fact been received by the container capture assembly **102**, the Controller will activate the Z-drive motor in reverse direction to pivotally retract the container capture assembly **102** back into the carrier frame assembly **90** until the Z-in switch **229** indicates that the container capture assembly **102** is fully returned in nesting position within the carrier frame assembly **90 (314)**. As the container capture assembly **102** is withdrawn back into the carrier frame assembly **90**, its forward edge will release pressure against the forward cam surface of the foremost portion **110***a* of the primary lever

guide arm **110**, enabling the lever guide arm **110** to be retracted to its normal position under influence of the spring **118**. As the lever guide arm **110** rotates back to its initial position, the second lever arm **114** will once again restore the container engaging rod member **116** to its blocking position across the open end of the selected tray, while motion of the rearward portion of the lever guide arm **110** will withdraw the container engaging rod member **113** from its engagement with the previously second-in-line container. As the rod member **113** releases its contact with the container the second-in-line container will slide under the force of gravity along die tray floor until it comes into resting engagement with the rod member **116**. In this position, the previously second-in-line container now becomes the first-in-line container in that selected product tray. Simultaneously, all of the other queued containers carried by that tray will also simultaneously move "forward" in the tray, each advancing one position, toward the dispensing end of the tray. This process is schematically indicated in FIG. **13** for a full vend cycle from the tray. The entire process of having transferred the selected container from the selected tray and into the container capture assembly **102** is achieved in smooth continuous manner without dropping the container or imparting any jarring blows or forces to the container.

Once the Z-motor has stabilized following activation of the Z-in switch **229**, the X and Y drive motors **77** and **97** respectively are simultaneously energized to move the shuttle bar **75** and the carrier frame assembly **90** back to the "first" X-position, carrying the captured selected container to that position **(315)**. The floor detent **108***a* and the tapered beverage container guides **107** of the container capture assembly **102** help support and hold the captured container within the container capture assembly during the transport phase. Once the carrier frame assembly **90** reaches the first position, the X-drive motor **77** is activated to move the shuttle bar so as to move the carrier frame assembly **90** to the X "home" position at which point the carrier frame assembly will cooperatively nest within the door opening assembly **120** such that the access ports **121***a*, **102***a* and **90***b* are all in operative alignment **(316)**.

At the X "home" position, both the X and the Y drive motors are deenergized and the carrier frame assembly **90** is locked in position by the locking motor **218** at the delivery station **(317)**. With the lock set, the Controller energizes the delivery door motor **123** until the door open switch **131** indicates that the delivery door is in a fully open position **(318)**. The Controller then interrogates the product present sensor **222** in the container capture assembly **102** (decision block **319**) to determine when the captured container is removed from the container capture assembly **102**. When the delivery door opens, the customer making the beverage or container selection simply needs to reach into the delivery access port **32** and lift the delivered container forward and up out of the container capture assembly. Since the delivery access port **32** is located at a higher (approximately waist) level then most vending machine delivery vends, the customer does not have to unduly bend or contort his/her body in order to remove the selected container from the machine.

When the delivered container has been removed from the delivery port, the product present sensor **222** will inform the Controller of that fact, and after a two-second delay **(320)** the Controller will energize the delivery door motor **123** so as to close the delivery door **(321)**. Once the delivery door is closed, as indicated by activation of the door closed switch **130**, the vend cycle is complete **(322)**. Following a successful vend, vend housekeeping matters such as incrementing of the electronic cash counter and the vend counter, etc. will be performed as is well-known in the art.

It will be appreciated that the above process provides a smooth continuous vending sequence, all in view of the customer, to deliver the selected container to the customer without jarring, dropping, or rolling of the container, or otherwise subjecting the container to sharp or severe impact forces. Upon removal of the container from the delivery port, the consumer can immediately open the container without concern for its contents exploding, or foaming out of the container, and without concern for damage being caused to fragile containers during the vending process. It will also be appreciated that since the delivery port is located in the side control panel, that area near the bottom of the machine that with prior art devices was used for delivery bins, can be used to advantage to store more product within the machine. It will also be appreciated that the apparatus and process allows for greater flexibility in arranging products of varied sizes, shapes, volumes and types of containers within the same machine and that the delivery door position is accommodating to the consumer. It will also be appreciated that implementation of the principles of the invention can be achieved in an economical manner since none of the product trays or shelves require any active and expensive components in order to effect a vend. These and other features and advantages of the invention will be readily apparent to those skilled in the art in view of the foregoing description.

It will be appreciated that while preferred embodiment descriptions and applications of the invention have been disclosed other modifications of the invention not specifically disclosed or referred to herein will be apparent to those skilled in the art in light of the foregoing description. This description is intended to provide concrete examples of preferred embodiment structures and applications clearly disclosing the present invention and its operative principles. Accordingly, the invention is not limit to any particular embodiment or configuration or component parts thereof. All alternatives, modifications and variations of the present invention which fall within the spirit and broad scope of the appended claims are covered.

We claim:

1. In combination with a vending machine of the type having a storage facility defining an enclosed internal cavity, a front panel through which products are vended; and a plurality of trays for retainably holding product containers configured in sealed geometric shapes, wherein said trays comprise:

a) elongate generally U-shaped channels extending from a rear end toward a dispensing end; wherein said containers are held in ordered alignment within said channel and are dispensed from said tray through said dispensing end thereof;

b) supports for operatively mounting said trays within said vending machine such that the dispensing ends of said trays are aligned generally within a vertical plane adjacent said front panel of the vending machine; and

c) a reinforcement structure secured to said trays adjacent said dispensing ends thereof for maintaining dimensional width tolerances across the dispensing end of the tray in a manner that prevents bending distortion of the tray at said dispensing end thereof.

2. The apparatus of claim **1**, wherein said reinforcement structure comprises a yoke structure forming the dispensing end of the tray.

3. The apparatus of claim **2**, wherein said yoke structure is formed of cast material.

4. The apparatus of claim 3, wherein said cast material comprises at least in part, zinc.

5. The apparatus of claim 2, wherein said yoke structure is configured to support the dispensing end of at least two of said trays.

6. The apparatus of claim 1, wherein said reinforcement structure comprises a yoke structure mounted to the tray adjacent said dispensing end thereof.

7. The apparatus of claim 1, wherein said reinforcement structure maintains a dimensional width parameter as measured between opposed side walls of the tray adjacent the dispensing end thereof, within 5%.

8. The apparatus of claim 7, wherein any change of said dimensional width parameter is no greater than 0.01 inch.

9. The apparatus of claim 1, wherein said yoke structure extends along a floor portion and up along at least one sidewall portion of the tray.

10. The apparatus of claim 1 wherein at least one of said tray supports comprises a support for slidably supporting said tray within said vending machine, for movement of said tray in a longitudinal direction of the tray.

11. The apparatus of claim 10, further including a lockout assembly mounted to said tray for preventing movement of containers held by said tray through said dispensing end when said tray is moved out of an operative vending position.

12. The apparatus of claim 11, wherein said lockout assembly is attached to said tray adjacent said dispensing end thereof.

13. The apparatus of claim 11, wherein said reinforcement structure comprises a yoke structure adjacent the dispensing end of the tray, and wherein said lockout assembly is mounted to said yoke structure.

14. The apparatus of claim 10, wherein said slidable support is configured to slidably support at least two said trays, but less than an entire horizontal shelf or vertical column of said trays mounted within the vending machine.

15. The apparatus of 10 further including a container release assembly mounted adjacent the dispensing end of the tray, said container release assembly being movable with the dispensing end of the tray.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,513,677 B1
DATED : February 4, 2003
INVENTOR(S) : Sorensen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

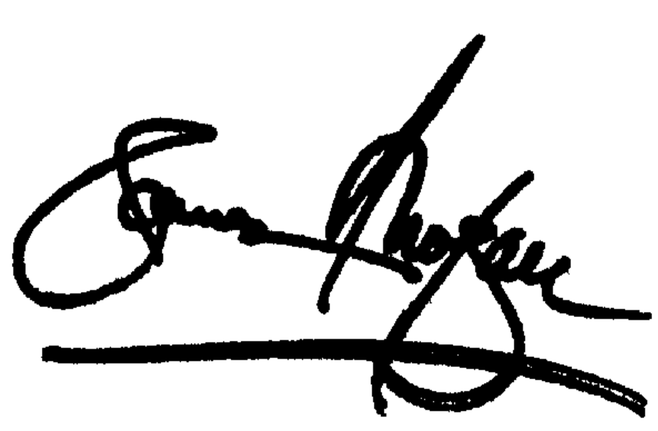
Column 22,
Line 63, "door:opening" should read -- door opening --

Column 29,
Line 12, "die" should read -- the --

Column 32,
Line 16, "apparatus of 10" should read -- apparatus of claim 10 --

Signed and Sealed this

Twenty-second Day of July, 2003



JAMES E. ROGAN
Director of the United States Patent and Trademark Office